

Machines & Motion

Teacher Supplement



*God's Design® for Physical World
Machines & Motion Teacher Supplement*

Printed January 2016

Fourth edition. Copyright © 2008, 2016 by Debbie & Richard Lawrence

No part of this book may be reproduced in any form or by any means without written permission from the author and publisher other than: (1) the specific pages within the book that are designed for single family/classroom use, and (2) as brief quotations quoted in a review.

ISBN: 978-1-62691-464-3

Published by Answers in Genesis, 2800 Bullittsburg Church Rd., Petersburg KY 41080

Book designer: Diane King

Editors: Gary Vaterlaus

All scripture quotations are taken from the New King James Version. Copyright 1982 by Thomas Nelson, Inc. Used by permission. All rights reserved.

The publisher and authors have made every reasonable effort to ensure that the activities recommended in this book are safe when performed as instructed but assume no responsibility for any damage caused or sustained while conducting the experiments and activities. It is the parents', guardians', and/or teachers' responsibility to supervise all recommended activities.

Printed in China.

Teacher Introduction	5
Answer Key	15
Mechanical Forces	14
Simple Machines	22
Kinematics.	30
Dynamics	33
Circular & Periodic Motion	38
Use of Machines	41
Resource Guide.	46
Master Supply List.	47
Works Cited	48



Welcome to GOD'S DESIGN®

PHYSICAL WORLD



God's Design for the Physical World is a series that has been designed for use in teaching physical science to elementary and middle school students. It is divided into three books: *Heat and Energy*, *Machines and Motion*, and *Inventions and Technology*. Each book has 35 lessons including a final project that ties all of the lessons together.

In addition to the lessons, special features in each book include biographical information on interesting people as well as fun facts to make the subject more fun.

Although this is a complete curriculum, the information included here is just a beginning, so please feel free to add to each lesson as you see fit. A resource guide is included in the appendices to help you find additional information and resources. A list of supplies needed is included at the beginning of each lesson, while a master list of all supplies needed for the entire series can be found in the appendices.

Answer keys for all review questions, worksheets, quizzes, and the final exam are included here. Reproducible student worksheets and tests may be found in the digital download that comes with the purchase of the curriculum. You may download these files from GodsDesign.com/PhysicalWorld.

If you prefer the files on a CD-ROM, you can order that from Answers in Genesis at an additional cost by calling 800-778-3390.

If you wish to get through all three books of the *Physical World* series in one year, you should plan on covering approximately three lessons per week. The time required for each lesson varies depending on how much additional information you want to include, but you can plan on about 45 minutes per lesson.

If you wish to cover the material in more depth, you may add additional information and take a longer period of time to cover all the material or you could choose to do only one or two of the books in the series as a unit study.

Why Teach Physical Science?

Maybe you hate science or you just hate teaching it. Maybe you love science but don't quite know how to teach it to your children. Maybe science just doesn't seem as important as some of those other subjects you need to teach. Maybe you need a little motivation. If any of these descriptions fits you, then please consider the following.

It is not uncommon to question the need to teach your kids hands-on science in elementary school. We could argue that the knowledge gained in science will be needed later in life in order for your children to be more productive and well-rounded adults. We could argue that teaching your children science also teaches them logical and inductive thinking and reasoning

skills, which are tools they will need to be more successful. We could argue that science is a necessity in this technological world in which we live. While all of these arguments are true, not one of them is the real reason that we should teach our children science. The most important reason to teach science in elementary school is to give your children an understanding that God is our Creator, and the Bible can be trusted. Teaching science from a creation perspective is one of the best ways to reinforce your children's faith in God and to help them counter the evolutionary propaganda they face every day.

God is the Master Creator of everything. His handiwork is all around us. Our Great Creator put in place all of the laws of physics, biology, and chemistry. These laws were put here for us to see His wisdom and power. In science, we see the hand of God at work more than in any other subject. Romans 1:20 says, "For since the creation of the world His invisible attributes are clearly seen, being understood by the things that are made, even His eternal power and Godhead, so that they [men] are without excuse." We need to help our children see God as Creator

of the world around them so they will be able to recognize God and follow Him.

The study of physical science helps us to understand and appreciate the amazing way everything God created works together. The study of energy helps us understand that God set up the universe with enough energy to sustain life and that He created the sun to replenish the energy used up each day. The study of friction and movement helps us appreciate the laws of motion and helps us understand how simple machines can be used to do big things. And finally, studying inventions and technology will not only help us understand the technological world in which we live, but will help us realize that God created man to be creative just like Him.

It's fun to teach physics. It's interesting too. Energy and motion are all around us. We use technology and inventions every day. Finally, teaching physics is easy. You won't have to try to find strange materials for experiments or do dangerous things to learn about physics. Physics is as close as your child's toy box or the telephone—it's the rainbow in the sky and it's the light bulb in the lamp. So enjoy your study of the physical world.

How Do I Teach Science?

In order to teach any subject you need to understand how people learn. People learn in different ways. Most people, and children in particular, have a dominant or preferred learning style in which they absorb and retain information more easily.

If a student's dominant style is:

Auditory
He needs not only to hear the information but he needs to hear himself say it. This child needs oral presentation as well as oral drill and repetition.
Visual
She needs things she can see. This child responds well to flashcards, pictures, charts, models, etc.
Kinesthetic
He needs active participation. This child remembers best through games, hands-on activities, experiments, and field trips.

Also, some people are more relational while others are more analytical. The relational student needs to know why this subject is important, and how it will

affect him personally. The analytical student, however, wants just the facts.

If you are trying to teach more than one student, you will probably have to deal with more than one learning style. Therefore, you need to present your lessons in several different ways so that each student can grasp and retain the information.

Grades 3–8

The first part of each lesson should be completed by all upper elementary and junior high students. This is the main part of the lesson containing a reading section, a hands-on activity that reinforces the ideas in the reading section (blue box), and a review section that provides review questions and application questions.

Grades 6–8

In addition, for middle school/junior high age students, we provide a "Challenge" section that contains more challenging material as well as additional activities and projects for older students (green box).

We have included periodic biographies to help your students appreciate the great men and women who have gone before us in the field of science.

We suggest a threefold approach to each lesson:

Introduce the topic

We give a brief description of the facts. Frequently you will want to add more information than the essentials given in this book. In addition to reading this section aloud (or having older children read it on their own), you may wish to do one or more of the following:

- Read a related book with your students.
- Write things down to help your visual learners.
- Give some history of the subject. We provide some historical sketches to help you, but you may want to add more.
- Ask questions to get your students thinking about the subject.

Make observations and do experiments

- Hands-on projects are suggested for each lesson. This part of each lesson may require help from the teacher.
- Have your students perform the activity by themselves whenever possible.

Review

- The “What did we learn?” section has review questions.
- The “Taking it further” section encourages students to
 - Draw conclusions
 - Make applications of what was learned
 - Add extended information to what was covered in the lesson
- The “FUN FACT” section adds fun or interesting information.

By teaching all three parts of the lesson, you will be presenting the material in a way that children with any learning style can both relate to and remember.

Also, this approach relates directly to the scientific method and will help your students think more scientifically. The *scientific method* is just a way to examine a subject logically and learn from it. Briefly, the steps of the scientific method are:

1. Learn about a topic.
2. Ask a question.
3. Make a hypothesis (a good guess).
4. Design an experiment to test your hypothesis.
5. Observe the experiment and collect data.
6. Draw conclusions. (Does the data support your hypothesis?)

Note: It’s okay to have a “wrong hypothesis.” That’s how we learn. Be sure to help your students understand why they sometimes get a different result than expected.

Our lessons will help your students begin to approach problems in a logical, scientific way.

How Do I Teach Creation vs. Evolution?

We are constantly bombarded by evolutionary ideas about the earth in books, movies, museums, and even commercials. These raise many questions: Do physical processes support evolutionary theories? Do physical laws support an old earth? Do changes in the magnetic field support an old earth? The Bible answers these ques-

tions, and this book accepts the historical accuracy of the Bible as written. We believe this is the only way we can teach our children to trust that everything God says is true.

There are five common views of the origins of life and the age of the earth:

Historical biblical account	Progressive creation	Gap theory	Theistic evolution	Naturalistic evolution
Each day of creation in Genesis is a normal day of about 24 hours in length, in which God created everything that exists. The earth is only thousands of years old, as determined by the genealogies in the Bible.	The idea that God created various creatures to replace other creatures that died out over millions of years. Each of the days in Genesis represents a long period of time (day-age view) and the earth is billions of years old.	The idea that there was a long, long time between what happened in Genesis 1:1 and what happened in Genesis 1:2. During this time, the “fossil record” was supposed to have formed, and millions of years of earth history supposedly passed.	The idea that God used the process of evolution over millions of years (involving struggle and death) to bring about what we see today.	The view that there is no God and evolution of all life forms happened by purely naturalistic processes over billions of years.

Any theory that tries to combine the evolutionary time frame with creation presupposes that death entered the world before Adam sinned, which contradicts what God has said in His Word. The view that the earth (and its “fossil record”) is hundreds of millions of years old damages the gospel message. God’s completed creation was “very good” at the end of the sixth day (Genesis 1:31). Death entered this perfect paradise *after* Adam disobeyed God’s command. It was the punishment for Adam’s sin (Genesis 2:16–17; 3:19; Romans 5:12–19). Thorns appeared when God cursed the ground because of Adam’s sin (Genesis 3:18).

The first animal death occurred when God killed at least one animal, shedding its blood, to make clothes for Adam and Eve (Genesis 3:21). If the earth’s “fossil record” (filled with death, disease, and thorns) formed over millions of years before Adam appeared (and

before he sinned), then death no longer would be the penalty for sin. Death, the “last enemy” (1 Corinthians 15:26), diseases (such as cancer), and thorns would instead be part of the original creation that God labeled “very good.” No, it is clear that the “fossil record” formed sometime *after* Adam sinned—not many millions of years before. Most fossils were formed as a result of the worldwide Genesis Flood.

When viewed from a biblical perspective, the scientific evidence clearly supports a recent creation by God, and not naturalistic evolution and millions of years. The volume of evidence supporting the biblical creation account is substantial and cannot be adequately covered in this book. If you would like more information on this topic, please see the resource guide in the appendices To help get you started, just a few examples of evidence supporting biblical creation are given below:

Evolutionary Myth: Physical processes support evolution.

The Truth: Much of what scientists observe directly contradicts the ideas of evolution. Certain physical properties have been observed and tested to the point that they have been declared to be physical laws. The first law of thermodynamics states that matter and energy cannot be created or destroyed; they can only change form. There is no mechanism in nature for creating either energy or matter. Therefore, evolutionists cannot explain how all of the matter and energy in the universe came to be. This is a topic most evolutionists tend to ignore. The Bible tells us that God created it all and set it in motion.

The second law of thermodynamics states that all systems move toward a state of maximum entropy. This means that everything moves toward total disorganization and equilibrium. Heat moves from an area of higher temperature to an area of lower temperature, and organized systems become disorganized. For example, an organized system of cells that makes up a living creature quickly becomes disorganized when that creature dies. A house left to itself will eventually crumble into dust. Everything around us says that without intervention, chaos and disorganization result. Evolutionists, however, believe that by accident, simple molecules and simple organisms combined to form more complex molecules and organisms. This flies in the face of the second law of thermodynamics and everything that is observed to happen naturally. The changes required for the formation of the universe, the planet earth and life, all from disorder, run counter to the physical laws we see at work today. There is no known mechanism to harness the raw energy of the universe and generate the specified complexity we see all around us.¹

A third physical property that contradicts evolution is the small amount of helium in the atmosphere. Helium is naturally generated by the radioactive decay of elements in the earth's crust. Because helium is so light, it quickly moves up through the rocks and into the atmosphere. Helium is entering the atmosphere at about 13 million atoms per square inch per second (67 grams/second). Some helium atoms are also escaping the atmosphere into space, but the amount of helium escaping into space is only about 1/40th the amount entering the atmosphere. So, the overall amount of helium in the atmosphere is continually increasing. If you assume that helium cannot enter the atmosphere any other way, which is a reasonable assumption, then the amount of helium in the atmosphere indicates that the earth could be no more than two million years old, which is much less than the billions of years needed for evolution. This is a maximum age—the actual age could be much less since this calculation assumes that the original atmosphere had no helium whatsoever. Also, helium could have been released at a much greater rate during the time after the Genesis Flood. Therefore, the amount of helium in the atmosphere indicates a much younger earth than evolutionists claim.²

¹ John D. Morris, *The Young Earth* (Colorado Springs: Creation Life Publishers, 1994), p. 43. See also www.answersingenesis.org/go/thermodynamics.

² *Ibid.*, pp. 83–85.

Evolutionary Myth: Changes in the earth's magnetic field indicate an earth that is billions of years old.

The Truth: Most scientists agree on some fundamental facts concerning the earth's magnetic field. The earth is a giant electromagnet. The earth is surrounded by a magnetic field that is believed to be generated by current flowing through the interior of the earth. And there is evidence that the magnetic field of the earth has reversed several times. Also, nearly everyone agrees that the magnetic field is decreasing. The disagreement between evolutionists and creationists concerns how long it takes for the earth's magnetic field to change and what caused or causes the changes. Evolutionists believe that the magnetic field slowly decreases over time, reverses, and then slowly increases again. There are some serious problems with this idea. First, when the magnetic field is very low the earth would have no protection from very harmful radiation from the sun. This would be detrimental to life on earth. Second, at the current rate of decay, the magnetic field of the earth would lose half its energy about every 1,460 years. If the rate of decay is constant, the magnetic field would have been so strong only 20,000 years ago that it would have caused massive heating in the earth's crust and would have killed all life on earth. This supports the idea of an earth that is only about 6,000 years old, as taught in the Bible.

Creationists believe that the magnetic field reversals happened very quickly, and that the decay rate is fairly constant. One study of a lava flow indicated that reversals occurred in only 15 days. Thus, the reversals likely happened as a result of the Genesis Flood when the tectonic plates were moving and the earth's crust was in upheaval.³

³ Ibid., pp. 74–83.

Despite the claims of many scientists, if you examine the evidence objectively, it is obvious that evolution and millions of years have not been proven. You can be confident that if you teach that what the Bible says is true, you won't go wrong. Instill in your student a confidence in the truth of the Bible in all areas. If scientific thought seems to contradict the Bible, realize that scientists often make mistakes, but God does not lie. At one time scientists believed

that the earth was the center of the universe, that living things could spring from non-living things, and that blood-letting was good for the body. All of these were believed to be scientific facts but have since been disproved, but the Word of God remains true. If we use modern "science" to interpret the Bible, what will happen to our faith in God's Word when scientists change their theories yet again?

Integrating the Seven C's

The Seven C's is a framework in which all of history, and the future to come, can be placed. As we go through our daily routines we may not understand how the details of life connect with the truth that we find in the Bible. This is also the case for students. When discussing the importance of the Bible you may find yourself telling students that the Bible is relevant in everyday activities. But how do we help the younger generation see that? The Seven C's are intended to help.

The Seven C's can be used to develop a biblical worldview in students, young or old. Much more than entertaining stories and religious teachings, the Bible has real connections to our everyday life. It may be hard, at first, to see how many connections there are, but with practice, the daily relevance of God's Word will come alive. Let's look at the Seven C's of History and how each can be connected to what the students are learning.



Creation

God perfectly created the heavens, the earth, and all that is in them in six normal-length days around 6,000 years ago.

This teaching is foundational to a biblical worldview and can be put into the context of any subject. In science, the amazing design that we see in nature—whether in the veins of a leaf or the complexity of your hand—is all the handiwork of God. Virtually all of the lessons in *God's Design for Science* can be related to God's creation of the heavens and earth.

Other contexts include:

Natural laws—any discussion of a law of nature naturally leads to God's creative power.

DNA and information—the information in every living thing was created by God's supreme intelligence.

Mathematics—the laws of mathematics reflect the order of the Creator.

Biological diversity—the distinct kinds of animals that we see were created during the Creation Week, not as products of evolution.

Art—the creativity of man is demonstrated through various art forms.

History—all time scales can be compared to the biblical time scale extending back about 6,000 years.

Ecology—God has called mankind to act as stewards over His creation.



Corruption

After God completed His perfect creation, Adam disobeyed God by eating the forbidden fruit. As a result, sin and death entered the world, and the world has been in decay since that time. This point is evident throughout the world that we live in. The struggle for survival in animals, the death of loved ones, and the violence all around us are all examples of the corrupting influence of sin.

Other contexts include:

Genetics—the mutations that lead to diseases, cancer, and variation within populations are the result of corruption.

Biological relationships—predators and parasites result from corruption.

History—wars and struggles between mankind, exemplified in the account of Cain and Abel, are a result of sin.



Catastrophe

God was grieved by the wickedness of mankind and judged this wickedness with a global Flood. The Flood covered the entire surface of the earth and killed all air-breathing creatures that were not aboard the Ark. The eight people and the animals aboard the Ark replenished the earth after God delivered them from the catastrophe.

The catastrophe described in the Bible would naturally leave behind much evidence. The studies of geology and of the biological diversity of animals on the planet are two of the most obvious applications of this event. Much of scientific understanding is based on how a scientist views the events of the Genesis Flood.

Other contexts include:

Biological diversity—all of the birds, mammals, and other air-breathing animals have populated the earth from the original kinds which left the Ark.

Geology—the layers of sedimentary rock seen in roadcuts, canyons, and other geologic features are testaments to the global Flood.

Geography—features like mountains, valleys, and plains were formed as the floodwaters receded.

Physics—rainbows are a perennial sign of God’s faithfulness and His pledge to never flood the entire earth again.

Fossils—Most fossils are a result of the Flood rapidly burying plants and animals.

Plate tectonics—the rapid movement of the earth’s plates likely accompanied the Flood.

Global warming/Ice Age—both of these items are likely a result of the activity of the Flood. The warming we are experiencing today has been present since the peak of the Ice Age (with variations over time).



Confusion

God commanded Noah and his descendants to spread across the earth. The refusal to obey this command and the building of the tower at Babel caused God to judge this sin. The common language of the people was confused and they spread across the globe as groups with a common language. All people are truly of “one blood” as descendants of Noah and, originally, Adam.

The confusion of the languages led people to scatter across the globe. As people settled in new areas, the traits they carried with them became concentrated in those populations. Traits like dark skin were beneficial in the tropics while other traits benefited populations in northern climates, and distinct people groups, not races, developed.

Other contexts include:

Genetics—the study of human DNA has shown that there is little difference in the genetic makeup of the so-called “races.”

Languages—there are about seventy language groups from which all modern languages have developed.

Archaeology—the presence of common building structures, like pyramids, around the world confirms the biblical account.

Literature—recorded and oral records tell of similar events relating to the Flood and the dispersion at Babel.



Christ

God did not leave mankind without a way to be redeemed from its sinful state. The Law was given to Moses to show how far away man is from God’s standard of perfection. Rather than the sacrifices, which only covered sins, people needed a Savior to take away their sin. This was accomplished when Jesus Christ came to earth to live a perfect life and, by that obedience, was able to be the sacrifice to satisfy God’s wrath for all who believe.

The deity of Christ and the amazing plan that was set forth before the foundation of the earth is the core of Christian doctrine. The earthly life of Jesus was the fulfillment of many prophecies and confirms the truthfulness of the Bible. His miracles and presence in human form demonstrate that God is both intimately concerned with His creation and able to control it in an absolute way.

Other contexts include:

Psychology—popular secular psychology teaches of the inherent goodness of man, but Christ has lived the only perfect life. Mankind needs a Savior to redeem it from its unrighteousness.

Biology—Christ’s virgin birth demonstrates God’s sovereignty over nature.

Physics—turning the water into wine and the feeding of the five thousand demonstrate Christ’s deity and His sovereignty over nature.

History—time is marked (in the western world) based on the birth of Christ despite current efforts to change the meaning.

Art—much art is based on the life of Christ and many of the masters are known for these depictions, whether on canvas or in music.



Cross

Because God is perfectly just and holy, He must punish sin. The sinless life of Jesus Christ was offered as a substitutionary sacrifice for all of those who will repent and put their faith in the Savior. After His death on the Cross, He defeated death by rising on the third day and is now seated at the right hand of God.

The events surrounding the Crucifixion and Resurrection have a most significant place in the life of Christians.

Though there is no way to scientifically prove the Resurrection, there is likewise no way to prove the stories of evolutionary history. These are matters of faith founded in the truth of God's Word and His character. The eyewitness testimony of over 500 people and the written Word of God provide the basis for our belief.

Other contexts include:

Biology—the biological details of the Crucifixion can be studied alongside the anatomy of the human body.

History—the use of Crucifixion as a method of punishment was short-lived in historical terms and not known at the time it was prophesied.

Art—the Crucifixion and Resurrection have inspired many wonderful works of art.



Consummation

God, in His great mercy, has promised that He will restore the earth to its original state—a world without death, suffering, war, and disease. The corruption introduced by Adam's sin will be removed. Those who have repented and put their trust in the completed work of Christ on the Cross will experience life in this new heaven and earth. We will be able to enjoy and worship God forever in a perfect place.

This future event is a little more difficult to connect with academic subjects. However, the hope of a life in God's presence and in the absence of sin can be inserted in discussions of human conflict, disease, suffering, and sin in general.

Other contexts include:

History—in discussions of war or human conflict the coming age offers hope.

Biology—the violent struggle for life seen in the predator-prey relationships will no longer taint the earth.

Medicine—while we struggle to find cures for diseases and alleviate the suffering of those enduring the effects of the Curse, we ultimately place our hope in the healing that will come in the eternal state.

The preceding examples are given to provide ideas for integrating the Seven C's of History into a broad range of curriculum activities. We would recommend that you give your students, and yourself, a better understanding of the Seven C's framework by using AiG's *Answers for Kids* curriculum. The first seven lessons of this curriculum cover the Seven C's and will establish a solid understanding of the true history, and future, of the universe. Full lesson plans, activities, and student resources are provided in the curriculum set.

We also offer bookmarks displaying the Seven C's and a wall chart. These can be used as visual cues for the students to help them recall the information and integrate new learning into its proper place in a biblical worldview.

Even if you use other curricula, you can still incorporate the Seven C's teaching into those. Using this approach will help students make firm connections between biblical events and every aspect of the world around them, and they will begin to develop a truly biblical worldview and not just add pieces of the Bible to what they learn in "the real world."

Mechanical Forces

1

Introduction to Mechanical Energy

Let's get moving

Supply list

Tennis ball

String

Tennis racquet or baseball bat

Copy of "Types of Motion" worksheet

Types of Motion worksheet

Activity	Observed motion	Forces affecting movement of ball
1. Roll a tennis ball along the ground.	Straight line	Forward motion from hand, then slowed down by contact with the surface
2. Hold a tennis ball as high as you can and then drop it.	Straight down	Gravity
3. Hit a tennis ball with a tennis racquet or baseball bat into an open area.	Arc	Forward motion from racquet, gravity
4. Hit the tennis ball against a wall (with no windows).	Arc with a reflection of movement from wall	Forward motion from racquet, gravity, push from wall
5. Tie a string around the ball and swing it around your head. Be sure that no one is standing near you. After a few rotations, release the string.	Circular, then an arc in a straight line	Pull from your arm, gravity

- Did the ball move faster when you rolled it or when you hit it with a racquet or bat? **The ball will move faster when hit by the racquet.**
- What happened to the ball on a string when you let go of it? **The ball on a string went flying in a straight line, but fell in an arc.**
- Why didn't it keep spinning? **It no longer had a force pulling it toward the center.**

What did we learn?

- What is mechanics? **The study of motion or moving objects.**

- What is energy? **The ability to perform work.**
- What are some ways that objects move? **In straight lines, in arcs, in circles, etc.**

Taking it further

- What force greatly affects motion on earth? **Gravity.**
- List three or more ways that mechanical advantage is being used around you. **Door hinges, wheels, engines, nut crackers, scissors, automobiles, etc.**