TEACHER GUIDE

Includes Student Worksheets

10th–12th Grade

Science

Weekly Lesson Schedule
Labs
Supply List
Answer Key

Master's Class Physics

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CURRICULUM

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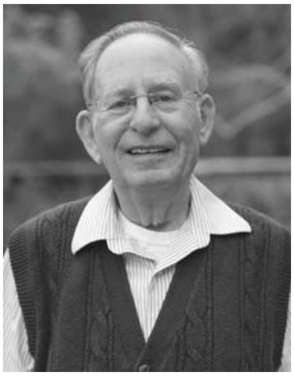

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Dr. Dennis Englin enjoys teaching in the areas of animal biology, vertebrate biology, wildlife biology, organismic biology, chemistry, and astronomy. Memberships include the Creation Research Society, Southern California Academy of Sciences, Yellowstone Association, and Au Sable Institute of Environmental Studies. Dr. Englin's most recent publications include a text currently used in *Principles of Biology*. His research interests are in the area of animal field studies. He is a retired Professor of Biology at The Master's University in Santa Clarita, California.

Table of Contents

100% GUARANTEE Faith Grower 100% GUARANTEE

Using This Teacher Guide

Features: The suggested weekly schedule enclosed has easy-to-manage lessons that guide the reading, worksheets, and all assessments. The pages of this guide are perforated and three-hole punched so materials are easy to tear out, hand out, grade, and store. Teachers are encouraged to adjust the schedule and materials needed in order to best work within their unique educational program.

Course Design: Everything is made of matter which possess' energy, and with physics, you can study their interactions in everything around us. This course is designed to teach students to learn and apply physics concepts to real life rather than simply memorizing them. Students will complete practice exercises and lab reports, take quizzes and exams, and conduct hands-on experiments as they see God's hand in every aspect of their study.

	Approximately five hours of course work each week
	Includes answer keys for worksheets, quizzes, lab reports, and exams
	Worksheets to help assess student learning
	Quizzes and exams are included to help reinforce learning and provide assessment opportunities
	Designed for grades 10 to 12 in a one-year course **Prerequisites: Algebra 1 and Chemistry**

Course Objectives: Students completing this course will

- Investigate the core concepts of physics, including scientific models
- Become familiar with the meanings of related scientific terms, such as velocity, acceleration, and kinetic and potential energy
- Use vectors as they demonstrate the direction and quantity of forces
- Learn about the conservation of matter and energy, and how matter and energy interact over time and space
- Conduct laboratory procedures and write reports with each week of study

Course Description

This is an introductory high school level course covering the basic concepts and applications of modern physics. It is designed to provide a background for life skills in an age when science is increasingly involved in everyday life. As well, it provides a sound foundation for those going on to college-level courses. Physics is the study of energy and how it causes motion and interactions of matter that we see all around us every day. In this course, students will gain a knowledge of how energy and matter interact, giving us insights into the origin of life so we can realize that life could only have been formed by a supernatural act of creation, not by a process of change over time.

This study is based on the principle that those who can understand and apply information do much better than those who simply memorize. Physics is usually considered to be a secular study, but students will find that the precise predictability, exact quantitative nature, and intricate detail of the study of energy and matter are a constant testimony to God's great wisdom and omnipotent and omnipresent control. The student should be able to see God in every aspect of this course. The goal of this study is physics as Christ would have us see it. But we have limited understandings because we are a part of His creation. Nevertheless, He has enabled people down through the years to understand parts of His creation to show His care and love to those created in His image. He develops our skills as we study, practice, and grow.

This is not a study that you can just walk through like a grassy field. Rather, it has a few cliffs to climb and streams to ford. Some areas will come easier than others and some will take more time and practice. As students study each lesson, they will have to complete practice exercises and take a weekly quiz. They will also conduct a laboratory procedure and write a report dealing with that week's lesson. About every 3 or 4 weeks, students will stop and review and take an examination. In everything studied, they will see God's never-changing nature and absolute control of the physical universe through the natural laws. **High school transcripts should list the course as Physics with labs.**

Vocabulary words are found in bold print in each chapter's text and with brief definitions in the glossary at the back of the book. Students are encouraged to either write these out on 3 x 5 cards or to create another useful means of reviewing these throughout their course of study. Comprehension of sometimes difficult terms and concepts is very important to completing a course in physics or any other complex science study.

Teacher Instructions for This Course

The teacher is the one who guides the student through the subject matter, helps the student stay on schedule and be organized, and is the source of accountability along the way. With that in mind, this guide provides additional help in guiding the student through the laboratory exercises and a list of supplies not readily available that need to be ordered. For the lessons, quizzes and examinations are provided along with the answers. Additional guidelines are included for the quizzes and examinations.

A study of this nature involves a lot of new concepts and terms. In the sciences, as well as other disciplines of life, the level of understanding grows in stages. As we progress through our education, we add layers of understanding and skills. This course is an introduction to basic terms and concepts of physics. It is not just intended for those going on for further studies in physics. It is essential to understand the sciences more in this technological age than it has been in the past.

Physics is a tool that helps us to understand most other aspects of life. Because understandings grow in stages, a good approach is to look for patterns that may be better understood in the future. Some things in life only have to be understood by patterns. An example is the use of a computer. We learn how to do certain tasks on the computer but most of us have no clue as to what went into the software that makes it all possible. Such is also the case for physics for many. The lessons in this study emphasize working through procedures and problem solving by learning patterns. The vocabulary is kept at the essential level.

Practice exercises are given with their answers so that the patterns can be used in problem solving. These lessons and laboratory exercises are the result of over 30 years of teaching homeschool high school students and then working with them as they proceed on to college. There are many principles and truths given to us in Scripture by the God who created the universe and all of the laws by which it functions. It is important to see the hand of God and His principles and wisdom as they play out in physics. I have tried to integrate what God has told us into the context of this study. Some have attempted this by putting Scripture verses into science texts, but unless it is in the context of the study, it gives the impression that it really does not apply. I hope as well that this study sharpens the student's ability to comprehend material, see and apply patterns, and increase their problem-solving skills.

You know that you have learned to use a pattern when you can study examples and then apply what you have observed to situations that you have never seen before. Perhaps it will lead to later being able to develop new and better explanations in physics and living life with God's direction.

Physics Credits for Transcripts

This is a one-year course with two full semesters, helping a student fulfill one credit of Physics with labs. High school transcripts should list the course as Physics with labs. If questions arise from state agencies or schools, they can be referred to the course content.

Teacher Instructions for the Laboratory

This information is given so that the teacher can come alongside the student in helping line up the necessary materials for each exercise, overseeing the procedures where necessary, and evaluating the Lab Reports. Be sure that complete sentences are used in the reports except items where data are being recorded. This provides added writing experience and is clearer to someone reading the report. Do not hesitate to ask someone with more background in physics to come alongside in areas where you may feel less confident.

Students are to use the "Laboratory" pages for taking their notes and marking general observations. The "Laboratory Report" pages (see samples on pages 11 and 12) are for the student to write out their full observations and conclusions. Any questions asked in the lab are to be answered here. The hypothesis/ purpose is stated with each lab.

WARNING: As with any science course that includes experiments, what is created can be potentially hazardous if not handled properly. Make sure to follow all instructions very carefully:

- ✔ wear proper safety equipment when needed, including gloves and safety goggles/glasses
- ✔ keep small children away from where the labs are conducted

Here is a list of supplies that need to be available for the labs. These are things that are not readily available outside of a science laboratory.

- ☐ 100 g weight
- ☐ 100 ml graduated cylinder
- ☐ 3.7 V bulbs (2)
- ☐ AA Battery holder (2)
- ☐ Bar magnet (set of 2)
- ☐ Biconvex lens, 50 mm fl
- ☐ Biconvex lens, 150 mm fl
- ☐ Biconcave lens, 150 mm fl
- ☐ Bulb holder (2)
- ☐ Circuit switch
- ☐ Color paddles
- ☐ Diffraction grating
- ☐ Digital scale
- ☐ Electric motor assembly kit
- ☐ Galvanometer
- ☐ Insulated wire
- ☐ Iron filings
- ☐ Metric ruler (3)
- ☐ Meter stick
- ☐ Mirror, concave, 200 mm focal length
- ☐ Mirror, convex, 200 mm focal length
- ☐ Multimeter
- ☐ *Stargazers Guide to the Night Sky*
- ☐ Red laser pointer
- ☐ Single beam penlight
- ☐ Single pulley (2)
- ☐ Solar cell 1V, 500 mA
- ☐ Spectroscope
- ☐ Spring scale (3)
- ☐ Thermometers (2)

☐ 100 g weight

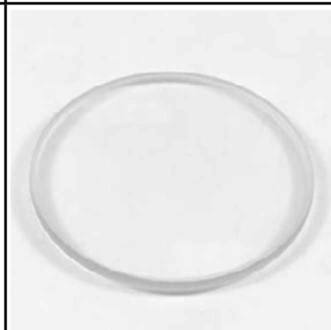
☐ 100 ml graduated cylinder

☐ 3.7 V bulbs (2)

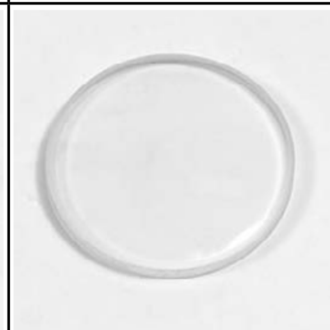
☐ AA Battery holder (2)

☐ Bar magnet (set of 2)

☐ Biconvex lens, 50 mm fl



☐ Biconvex lens, 150 mm fl



☐ Biconcave lens, 150 mm fl

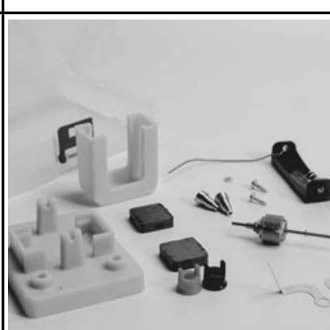
☐ Bulb holder (2)

☐ Circuit switch

☐ Color paddles

☐ Diffraction grating

☐ Digital scale



☐ Electric motor assembly kit

☐ Galvanometer

☐ Insulated wire

☐ Iron filings

☐ Metric ruler (3)

☐ Meter stick

☐ Mirror, concave, 200 mm focal length

☐ Mirror, convex, 200 mm focal length O

☐ Multimeter

☐ *Stargazers Guide to the Night Sky*

☐ Red laser pointer

☐ Single beam penlight

☐ Single pulley (2)

☐ Solar cell 1V, 500 mA

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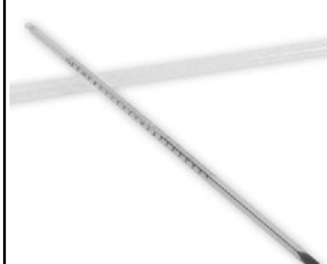
☐ Spring scale (3)



☐ Thermometers (2)

Laboratory Report (20 points possible)

1. Mass of aluminum boat *3.2* g
2. Mass of metal washer *2.4* g
3. *5* washers made the boat sink down to the 1 cm mark
4. The mass of the added washers

   5 (number of washers) × *2.4* g (mass of 1 washer) = *12* g

   Total mass = *12* g of washers + *3.2* g of boat = *15.2* g
5. Density of boat and washers

   $\frac{\textit{15.2}\text{ g of washers and boat}}{64\text{ cm}^3} = 0.24\ \frac{\text{g}}{\text{cm}^3}$ of the boat and washers that sank to 1 cm.
6. 26 washers made the boat sink to the bottom

   2.4 g of 1 washer × *26* washers = *62.4* g

   62.4 g of washers + *3.2* g of boat = *65.6* g

   Density of washers and boat that sank to the bottom

   $\frac{\textit{65.6}\text{ g of washers and boat}}{64\text{ cm}^3} = \textit{1.03}\ \frac{\text{g}}{\text{cm}^3}$
7. The density of water is 1.00 $\frac{\text{g}}{\text{cm}^3}$.
8. Write out your hypothesis as to why the boat floated in step 6 (of the instructions) and sank in step 7.

   An object with a density greater than water will sink because the boat is heavier than the volume of water displaced by the boat.
9. Explain how you tested your hypothesis.

   I made a boat of clay that had a mass of 25 g and a volume of 27 cm³ (3 cm × 3 cm × 3 cm) and a density of $\frac{25\ g}{27\ cm^3}$ *or 0.93* $\frac{g}{cm^3}$*. I predicted that it would float because 0.93* $\frac{g}{cm^3}$ *is less than 1.00* $\frac{g}{cm^3}$*. I added 5 g of clay to the boat and the boat had an overall mass of 30 g. The density of the boat now was* $\frac{30\ g}{27\ cm^3}$ *or 1.11* $\frac{g}{cm^3}$*. I predicted that it would sink because 1.11* $\frac{g}{cm^3}$ *is greater than 1.00* $\frac{g}{cm^3}$*.*
10. Using a complete sentence, did you support or reject your hypothesis?

    It supported my hypothesis.
11. Explain your reasoning in answering whether your hypothesis was supported or rejected. Use complete sentences.

    The predictions based upon my hypothesis came true. They supported but did not prove my hypothesis to be the reason why the boat floated because there could have been a better hypothesis that I did not think of.

Sample Physics Lab Reports Some of the numbers have been changed from what is asked for in the lab so that the students have to do their own work.

Laboratory Report (20 points possible)

1. Time it takes the ball to roll 2 meters

   Trial # 1 *2 seconds*

   Trial # 2 *3 seconds*

   Trial # 3 *3 seconds*

   Average time *2.7 seconds* (Add the 3 times and divide by 3)

2. $\frac{\text{Distance}}{\text{Average}}$ time $= \frac{2\,m}{2.7\,s} = 0.74\,\frac{\text{m}}{\text{s}}$

3. Is this speed or velocity? Explain.

   This is velocity because the ball rolled in a definite direction.

4. Describe the acceleration of the ball from the time it was released to the time that it stopped.

   The ball had a positive acceleration when it was released because its velocity increased and as it rolled it had a negative acceleration because it gradually slowed down and eventually stopped.

RATES OF FALL

5. Write out a statement as to how you think the rates of fall of the objects will compare to each other.

   The two objects will fall very close to the same rate allowing for minor experimental error of observation.

6. Mass of object # 1 *6 g = .006 kg*

   Mass of object # 2 *15 g = .015 kg*

7. Describe the rates of fall of the two objects. Did the heavier one fall much faster than the lighter one?

   The 2 objects fell at very close to the same rate because they hit the ground at almost the same time. The heavier object did not fall faster than the lighter object, allowing for slight differences in their release time.

8. What do you conclude about the rates of fall of the two objects? Do you agree with Aristotle, Galileo, or neither? Explain.

   The difference in mass between the 2 objects did not affect their rates of fall. This agrees with the conclusion of Galileo who did similar experiments and got the same result.

Sample Physics Lab Reports Some of the numbers have been changed from what is asked for in the lab so that the students have to do their own work.

Teacher Instructions for Quizzes and Examinations

Teacher's Instructions for Quizzes

The quizzes are to be given at the end of the study as per the schedule of the lessons. The students are to review the text of the lesson and the practice exercises. Grade the quiz from the answers in the teacher's guide. Have the student look up any questions that were missed and explain to you what the correct answer should be and why. The quizzes are multiple choice and matching (with few exceptions) to make grading easier on your part. There are 28 quizzes with 15 points possible for each quiz. This gives a total possible of 420 points. The customary grading scale is:

90%–100% is an A;
80%–89% is a B;
70%–79% is a C;
60%–69% is a D and
59% and lower is an F.

In science studies, an A and B are very good. C is average. D or F indicates the need for more maturity, more practice, or more study. Future success is always possible with maturity, study, and practice.

This applies to each individual quiz. At the end of the course, the average of the quizzes is to be added to the average of the exams to give a final score graded according to this scale. If a student misses more than 50% on a quiz, the quiz is to be retaken after careful study. You can give the student back ½ point for each answer gotten correct the second time that was missed the first time. This can be done for up to 5 quizzes. I have found this policy to be very helpful for students that get off to a slow start. As well, I have found that a student's readiness for a study of this nature depends more upon maturity rather than age. Always encourage your student but still hold the standard and do not cut corners. That way the student will have the assurance of being able to go on to further studies and succeed.

There is no midterm or final examination because by its very nature, physics is comprehensive. The concepts learned earlier are used in the later lessons and labs throughout the course.

Teacher's Instructions for Administering the Examinations

In the week of an examination, the student is to study the previous quizzes and the practice exercises for the lessons covered on the exam. The exam is like an expanded version of a quiz. Each exam consists of 30 multiple choice or matching questions (with few exceptions). The questions are not verbatim from the quizzes but are similar. An examination is a sampling of the material and does not include every point covered in the lessons.

A high school transcript usually has 1 grade for science courses (lab and lecture combined) and so this would appear as 1 credit with labs in Physics. (Note that some states may calculate credits in a different manner.) This can be determined by making the quizzes and exams 75 percent of the grade and the lab 25 percent of the grade. To find the lab grade take the total points earned from all of the labs divided by the total possible times 100. An example of finding the total grade is if the average of the quizzes and exams are 85 percent and the labs are 97 percent:

Quiz/Exam Average _85_ × 3 = _255_ + Lab _97_ = _352_ / 400 × 100 = _88% (B+)_ **Final Grade**

Grading Sheet

Lesson	Quiz	Exam	Lab
Lesson 1	________ / 15		________ / 20
Lesson 2	________ / 15		________ / 20
Lesson 3	________ / 15		________ / 20
Lesson 4	________ / 15	Examination 1 ________ / 30	________ / 20
Lesson 5	________ / 15		________ / 20
Lesson 6	________ / 15		________ / 20
Lesson 7	________ / 15		________ / 20
Lesson 8	________ / 15		________ / 20
Lesson 9	________ / 15	Examination 2 ________ / 30	________ / 20
Lesson 10	________ / 15		________ / 20
Lesson 11	________ / 15		________ / 20
Lesson 12	________ / 15	Examination 3 ________ / 30	________ / 20
Lesson 13	________ / 15		________ / 20
Lesson 14	________ / 15		________ / 20
Lesson 15	________ / 15		________ / 20
Lesson 16	________ / 15	Examination 4 ________ / 30	________ / 20
Lesson 17	________ / 15		________ / 20
Lesson 18	________ / 15		________ / 20
Lesson 19	________ / 15	Examination 5 ________ / 30	________ / 20
Lesson 20	________ / 15		________ / 20
Lesson 21	________ / 15		________ / 20
Lesson 22	________ / 15	Examination 6 ________ / 30	________ / 20
Lesson 23	________ / 15		________ / 20
Lesson 24	________ / 15		________ / 20
Lesson 25	________ / 15	Examination 7 ________ / 30	________ / 20
Lesson 26	________ / 15		________ / 20
Lesson 27	________ / 15		________ / 20
Lesson 28	________ / 15	Examination 8 ________ / 30	________ / 20
Total Score / Percent	_______ / 420 = _______ %	________ / 240 = __________ %	_______ / 560 = _______ %
	Quizzes ________ % + Examinations ________ % / 2 = ________ %		_______ %

Quiz/Exam Average _______ × 3 = _______ + Lab _______ = _______ / 400 × 100 = _______ **Final Grade**

First Semester Suggested Daily Schedule

Date	Day	Assignment	Due Date	✓	Grade
		First Semester-First Quarter			
Week 1	Day 1	Chapter 1 Physics, Wisdom, and Science • Read Pages 4–11 • *Physics* • (PH) Complete **Lesson 1 Worksheet 1** Pages 27–28 • *Teacher Guide* • (TG)			
	Day 2	Continue the study of Chapter 1; Focus on bolded Vocabulary Words			
	Day 3	Review Chapter 1 • Complete **Quiz 1** Page 197 • (TG)			
	Day 4	Do Laboratory 1 Archimedes' Principle Pages 12–13 • (PH)			
	Day 5	Conclude Laboratory 1 and Prepare **Lesson 1 Lab Report** Pages 29–31 • (TG)			
Week 2	Day 6	Chapter 2 Speed, Velocity, and Acceleration • Read Pages 14–19 • (PH) Complete **Lesson 2 Worksheet 1** Pages 33–34 • (TG)			
	Day 7	Continue the study of Chapter 2; Focus on Vocabulary Words			
	Day 8	Review Chapter 2 • Complete **Quiz 2** Pages 199–200 • (TG)			
	Day 9	Do Laboratory 2 Velocity and Acceleration Pages 20–21 • (PH)			
	Day 10	Conclude Laboratory 2 and Prepare **Lesson 2 Lab Report** Pages 35–37 • (TG)			
Week 3	Day 11	Chapter 3 Force and Newton's 3 Laws of Motion • Read Pages 22–27 • (PH) Complete **Lesson 3 Worksheet 1** Page 39 • (TG)			
	Day 12	Continue the study of Chapter 3; Focus on Vocabulary Words			
	Day 13	Review Chapter 3 • Complete **Quiz 3** Page 201 • (TG)			
	Day 14	Do Laboratory 3 Circular Motion and Newton's Laws of Motion Pages 28–29 • (PH)			
	Day 15	Conclude Laboratory 3 and Prepare **Lesson 3 Lab Report** Pages 41–44 • (TG)			
Week 4	Day 16	Chapter 4 Vectors • Read Pages 30–33 • (PH) Complete **Lesson 4 Worksheet 1** Pages 45–46 • (TG)			
	Day 17	Continue the study of Chapter 4; Focus on Vocabulary Words			
	Day 18	Review Chapter 4 • Complete **Quiz 4** Pages 203–206 • (TG)			
	Day 19	Do Laboratory 4 Vectors Pages 34–35 • (PH)			
	Day 20	Conclude Laboratory 4 and Prepare **Lesson 4 Lab Report** Pages 47–50 • (TG)			
Week 5	Day 21	Review Lesson 1 and Lesson 1 Quiz			
	Day 22	Review Lesson 2 and Lesson 2 Quiz			
	Day 23	Review Lesson 3 and Lesson 3 Quiz			
	Day 24	Review Lesson 4 and Lesson 4 Quiz			
	Day 25	Take **Examination 1 (Lessons 1–4)** Pages 257–260 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Week 6	Day 26	Chapter 5 Gravity • Read Pages 36–41 • (PH) Complete **Lesson 5 Worksheet 1** Pages 51–52 • (TG)			
	Day 27	Continue the study of Chapter 5; Focus on Vocabulary Words			
	Day 28	Review Chapter 5 • Complete **Quiz 5** Pages 207–208 • (TG)			
	Day 29	Do Laboratory 5 Gravity Pages 42–45 • (PH)			
	Day 30	Conclude Laboratory 5 and Prepare **Lesson 5 Lab Report** Pages 53–56 • (TG)			
Week 7	Day 31	Chapter 6 Kinetic Energy, Potential Energy, Momentum, and Power • Read Pages 46–53 • (PH) Complete **Lesson 6 Worksheet 1** Pages 57–58 • (TG)			
	Day 32	Continue the study of Chapter 6; Focus on Vocabulary Words			
	Day 33	Review Chapter 6 • Complete **Quiz 6** Pages 209–210 • (TG)			
	Day 34	Do Laboratory 6 Kinetic Energy, Momentum, Impact, and Power Pages 54–57 • (PH)			
	Day 35	Conclude Laboratory 6 and Prepare **Lesson 6 Lab Report** Pages 59–62 • (TG)			
Week 8	Day 36	Chapter 7 Work, Machines, and Torque • Read Pages 58–63 • (PH) Complete **Lesson 7 Worksheet 1** Pages 63–64 • (TG)			
	Day 37	Continue the study of Chapter 7; Focus on Vocabulary Words			
	Day 38	Review Chapter 7 • Complete **Quiz 7** Pages 211–212 • (TG)			
	Day 39	Do Laboratory 7 Machines and Mechanical Advantage Pages 64–65 • (PH)			
	Day 40	Conclude Laboratory 7 and Prepare **Lesson 7 Lab Report** Pages 65–68 • (TG)			
Week 9	Day 41	Chapter 8 Rotational Motion • Read Pages 66–71 • (PH) Complete **Lesson 8 Worksheet 1** Pages 69–70 • (TG)			
	Day 42	Continue the study of Chapter 8; Focus on Vocabulary Words			
	Day 43	Review Chapter 8 • Complete **Quiz 8** Page 213 • (TG)			
	Day 44	Do Laboratory 8 Rotational Motion Pages 72–73 • (PH)			
	Day 45	Conclude Laboratory 8 and Prepare **Lesson 8 Lab Report** Pages 71-73 • (TG)			
		First Semester-Second Quarter			
Week 1	Day 46	Review Lesson 5 and Lesson 5 Quiz			
	Day 47	Review Lesson 6 and Lesson 6 Quiz			
	Day 48	Review Lesson 7 and Lesson 7 Quiz			
	Day 49	Review Lesson 8 and Lesson 8 Quiz			
	Day 50	Take **Examination 2 (Lessons 5–8)** Pages 261–263 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Week 2	Day 51	Chapter 9 Projectile Motion • Read Pages 74–79 • (PH) Complete **Lesson 9 Worksheet 1** Pages 75–76 • (TG)			
	Day 52	Continue the study of Chapter 9; Focus on Vocabulary Words			
	Day 53	Review Chapter 9 • Complete **Quiz 9** Pages 215–216 • (TG)			
	Day 54	Do Laboratory 9 Projectile Motion Pages 80–81 • (PH)			
	Day 55	Conclude Laboratory 9 and Prepare **Lesson 9 Lab Report** Pages 77–80 • (TG)			
Week 3	Day 56	Chapter 10 Kepler's Laws of Planetary Motion • Read Pages 82–87 • (PH) Complete **Lesson 10 Worksheet 1** Pages 81–82 • (TG)			
	Day 57	Continue the study of Chapter 10; Focus on Vocabulary Words			
	Day 58	Review Chapter 10 • Complete **Quiz 10** Page 217 • (TG)			
	Day 59	Do Laboratory 10 Elliptical Orbits and Moon Phases Pages 88–89 • (PH)			
	Day 60	Conclude Laboratory 10 and Prepare **Lesson 10 Lab Report** Pages 83–85 • (TG)			
Week 4	Day 61	Chapter 11 Heat Energy • Read Pages 90–95 • (PH) Complete **Lesson 11 Worksheet 1** Pages 87–88 • (TG)			
	Day 62	Continue the study of Chapter 11; Focus on Vocabulary Words			
	Day 63	Review Chapter 11 • Complete **Quiz 11** Pages 219–220 • (TG)			
	Day 64	Do Laboratory 11 Heat Energy, Freezing Point of Water, and Relative Humidity Pages 96–97 • (PH)			
	Day 65	Conclude Laboratory 11 and Prepare **Lesson 11 Lab Report** Pages 89–92 • (TG)			
Week 5	Day 66	Chapter 12 Laws of Thermodynamics • Read Pages 98–103 • (PH) Complete **Lesson 12 Worksheet 1** Pages 93–94 • (TG)			
	Day 67	Continue the study of Chapter 12; Focus on Vocabulary Words			
	Day 68	Review Chapter 12 • Complete **Quiz 12** Page 221 • (TG)			
	Day 69	Do Laboratory 12 Second Law of Thermodynamics Pages 104–105 • (PH)			
	Day 70	Conclude Laboratory 12 and Prepare **Lesson 12 Lab Report** Pages 95–97 • (TG)			
Week 6	Day 71	Review Lesson 9 and Lesson 9 Quiz			
	Day 72	Review Lesson 10 and Lesson 10 Quiz			
	Day 73	Review Lesson 11 and Lesson 11 Quiz			
	Day 74	Review Lesson 12 and Lesson 12 Quiz			
	Day 75	Take **Examination 3 (Lessons 9–12)** Pages 265–267 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Week 7	Day 76	Chapter 13 Waves • Read Pages 106–111 • (PH) Complete **Lesson 13 Worksheet 1** Pages 99–100 • (TG)			
	Day 77	Continue the study of Chapter 13; Focus on Vocabulary Words			
	Day 78	Review Chapter 13 • Complete **Quiz 13** Pages 223–224 • (TG)			
	Day 79	Do Laboratory 13 Water Waves Pages 112–113 • (PH)			
	Day 80	Conclude Laboratory 13 and Prepare **Lesson 13 Lab Report** Pages 101–104 • (TG)			
Week 8	Day 81	Chapter 14 Sound Waves • Read Pages 114–119 • (PH) Complete **Lesson 14 Worksheet 1** Pages 105–106 • (TG)			
	Day 82	Continue the study of Chapter 14; Focus on Vocabulary Words			
	Day 83	Review Chapter 14 • Complete **Quiz 14** Page 225 • (TG)			
	Day 84	Do Laboratory 14 Sound Waves Pages 120–121 • (PH)			
	Day 85	Conclude Laboratory 14 and Prepare **Lesson 14 Lab Report** Pages 107–109 • (TG)			
Week 9	Day 86	Chapter 15 Musical Sound Waves • Read Pages 122–125 • (PH) Complete **Lesson 15 Worksheet 1** Page 111 • (TG)			
	Day 87	Continue the study of Chapter 15; Focus on Vocabulary Words			
	Day 88	Review Chapter 15 • Complete **Quiz 15** Page 227 • (TG)			
	Day 89	Do Laboratory 15 Musical Sound Waves Pages 126–127 • (PH)			
	Day 90	Conclude Laboratory 15 and Prepare **Lesson 15 Lab Report** Pages 113–115 • (TG)			
		Mid-Term Grade			

Second Semester Suggested Daily Schedule

Date	Day	Assignment	Due Date	✓	Grade
		Second Semester-Third Quarter			
Week 1	Day 91	Chapter 16 Electromagnetism • Read Pages 128–133 • (PH) Complete **Lesson 16 Worksheet 1** Pages 117–118 • (TG)			
	Day 92	Continue the study of Chapter 16; Focus on Vocabulary Words			
	Day 93	Review Chapter 16 • Complete **Quiz 16** Pages 229–230 • (TG)			
	Day 94	Do Laboratory 16 Electromagnetism Pages 134–135 • (PH)			
	Day 95	Conclude Laboratory 16 and Prepare **Lesson 16 Lab Report** Pages 119–122 • (TG)			
Week 2	Day 96	Review Lesson 13 and Lesson 13 Quiz			
	Day 97	Review Lesson 14 and Lesson 14 Quiz			
	Day 98	Review Lesson 15 and Lesson 15 Quiz			
	Day 99	Review Lesson 16 and Lesson 16 Quiz			
	Day 100	Take **Examination 4 (Lessons 13–16)** Pages 269–271 • (TG)			
Week 3	Day 101	Chapter 17 Light Waves — Electromagnetic Radiation • Read Pages 136–141 • (PH) Complete **Lesson 17 Worksheet 1** Page 123 • (TG)			
	Day 102	Continue the study of Chapter 17; Focus on Vocabulary Words			
	Day 103	Review Chapter 17 • Complete **Quiz 17** Page 231 • (TG)			
	Day 104	Do Laboratory 17 Light Waves — Electromagnetic Radiation Pages 142–143 • (PH)			
	Day 105	Conclude Laboratory 17 and Prepare **Lesson 17 Lab Report** Pages 125–128 • (TG)			
Week 4	Day 106	Chapter 18 Lenses — Refraction • Read Pages 144–147 • (PH) Complete **Lesson 18 Worksheet 1** Pages 129–130 • (TG)			
	Day 107	Continue the study of Chapter 18; Focus on Vocabulary Words			
	Day 108	Review Chapter 18 • Complete **Quiz 18** Page 233 • (TG)			
	Day 109	Do Laboratory 18 Lenses — Refraction Pages 148–149 • (PH)			
	Day 110	Conclude Laboratory 18 and Prepare **Lesson 18 Lab Report** Pages 131–134 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Week 5	Day 111	Chapter 19 Dispersion of Light and Reflection • Read Pages 150–155 • (PH) Complete **Lesson 19 Worksheet 1** Pages 135–136 • (TG)			
	Day 112	Continue the study of Chapter 19; Focus on Vocabulary Words			
	Day 113	Review Chapter 19 • Complete **Quiz 19** Page 235 • (TG)			
	Day 114	Do Laboratory 19 Dispersion of Light and Reflection Pages 156–157 • (PH)			
	Day 115	Conclude Laboratory 19 and Prepare **Lesson 19 Lab Report** Pages 137–140 • (TG)			
Week 6	Day 116	Review Lesson 17 and Lesson 17 Quiz			
	Day 117	Review Lesson 18 and Lesson 18 Quiz			
	Day 118	Review Lesson 19 and Lesson 19 Quiz			
	Day 119	Review Lessons 17–19			
	Day 120	Take **Examination 5 (Lessons 17–19)** Pages 273–274 • (TG)			
Week 7	Day 121	Chapter 20 Electric Circuits 1 • Read Pages 158–163 • (PH) Complete **Lesson 20 Worksheet 1** Pages 141–142 • (TG)			
	Day 122	Continue the study of Chapter 20; Focus on Vocabulary Words			
	Day 123	Review Chapter 20 • Complete **Quiz 20** Pages 237–238 • (TG)			
	Day 124	Do Laboratory 20 Electric Circuits Pages 164–165 • (PH)			
	Day 125	Conclude Laboratory 20 and Prepare **Lesson 20 Lab Report** Pages 143–146 • (TG)			
Week 8	Day 126	Chapter 21 Electric Circuits 2 • Read Pages 166–171 • (PH) Complete **Lesson 21 Worksheet 1** Pages 147–148 • (TG)			
	Day 127	Continue the study of Chapter 21; Focus on Vocabulary Words			
	Day 128	Review Chapter 21 • Complete **Quiz 21** Page 239 • (TG)			
	Day 129	Do Laboratory 21 Electric Motors and Solar Cells Pages 172–173 • (PH)			
	Day 130	Conclude Laboratory 21 and Prepare **Lesson 21 Lab Report** Pages 149–151 • (TG)			
Week 9	Day 131	Chapter 22 Atoms and Other Tiny Things • Read Pages 174–179 • (PH) Complete **Lesson 22 Worksheet 1** Pages 153–154 • (TG)			
	Day 132	Continue the study of Chapter 22; Focus on Vocabulary Words			
	Day 133	Review Chapter 22 • Complete **Quiz 22** Page 241 • (TG)			
	Day 134	Do Laboratory 22 Spectroscopy and Electron Orbitals Pages 180–181 • (PH)			
	Day 135	Conclude Laboratory 22 and Prepare **Lesson 22 Lab Report** Pages 155–158 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Second Semester-Fourth Quarter					
Week 1	Day 136	Review Lesson 20 and Lesson 20 Quiz			
	Day 137	Review Lesson 21 and Lesson 21 Quiz			
	Day 138	Review Lesson 22 and Lesson 22 Quiz			
	Day 139	Review Lessons 20–22			
	Day 140	Take **Examination 6 (Lessons 20–22)** Pages 275–276 • (TG)			
Week 2	Day 141	Chapter 23 Radioactivity • Read Pages 182–187 • (PH) Complete **Lesson 23 Worksheet 1** Pages 159–160 • (TG)			
	Day 142	Continue the study of Chapter 23; Focus on Vocabulary Words			
	Day 143	Review Chapter 23 • Complete **Quiz 23** Page 243 • (TG)			
	Day 144	Do Laboratory 23 Radioactivity Pages 188–189 • (PH)			
	Day 145	Conclude Laboratory 23 and Prepare **Lesson 23 Lab Report** Pages 161–163 • (TG)			
Week 3	Day 146	Chapter 24 Applications of Radioactivity • Read Pages 190–195 • (PH) Complete **Lesson 24 Worksheet 1** Page 165 • (TG)			
	Day 147	Continue the study of Chapter 24; Focus on Vocabulary Words			
	Day 148	Review Chapter 24 • Complete **Quiz 24** Page 245 • (TG)			
	Day 149	Do Laboratory 24 Applications of Radioactivity Pages 196–197 • (PH)			
	Day 150	Conclude Laboratory 24 and Prepare **Lesson 24 Lab Report** Pages 167–169 • (TG)			
Week 4	Day 151	Chapter 25 Time • Read Pages 198–203 • (PH) Complete **Lesson 25 Worksheet 1** Pages 171–172 • (TG)			
	Day 152	Continue the study of Chapter 25; Focus on Vocabulary Words			
	Day 153	Review Chapter 25 • Complete **Quiz 25** Page 247 • (TG)			
	Day 154	Do Laboratory 25 Time Pages 204–205 • (PH)			
	Day 155	Conclude Laboratory 25 and Prepare **Lesson 25 Lab Report** Pages 173–176 • (TG)			
Week 5	Day 156	Review Lesson 23 and Lesson 23 Quiz			
	Day 157	Review Lesson 24 and Lesson 24 Quiz			
	Day 158	Review Lesson 25 and Lesson 25 Quiz			
	Day 159	Review Lessons 23–25			
	Day 160	Take **Examination 7 (Lessons 23–25)** Pages 277–278 • (TG)			

Date	Day	Assignment	Due Date	✓	Grade
Week 6	Day 161	Chapter 26 The Solar System • Read Pages 206–213 • (PH) Complete **Lesson 26 Worksheet 1** Pages 177–178 • (TG)			
	Day 162	Continue the study of Chapter 26; Focus on Vocabulary Words			
	Day 163	Review Chapter 26 • Complete **Quiz 26** Pages 249–250 • (TG)			
	Day 164	Do Laboratory 26 The Night Sky Pages 214–215 • (PH)			
	Day 165	Conclude Laboratory 26 and Prepare **Lesson 26 Lab Report** Pages 179–181 • (TG)			
Week 7	Day 166	Chapter 27 The Universe • Read Pages 216–223 • (PH) Complete **Lesson 27 Worksheet 1** Pages 183–184 • (TG)			
	Day 167	Continue the study of Chapter 27; Focus on Vocabulary Words			
	Day 168	Review Chapter 27 • Complete **Quiz 27** Page 251 • (TG)			
	Day 169	Do Laboratory 27 Constellations and Planets Pages 224–225 • (PH)			
	Day 170	Conclude Laboratory 27 and Prepare **Lesson 27 Lab Report** Pages 185–187 • (TG)			
Week 8	Day 171	Chapter 28 Cosmology • Read Pages 226–231 • (PH) Complete **Lesson 28 Worksheet 1** Pages 189–190 • (TG)			
	Day 172	Continue the study of Chapter 28; Focus on Vocabulary Words			
	Day 173	Review Chapter 28 • Complete **Quiz 28** Page 253 • (TG)			
	Day 174	Do Laboratory 28 To Bring Glory to God Pages 232–233 • (PH)			
	Day 175	Conclude Laboratory 28 and Prepare **Lesson 28 Lab Report** Pages 191–193 • (TG)			
Week 9	Day 176	Review Lesson 26 and Lesson 26 Quiz			
	Day 177	Review Lesson 27 and Lesson 27 Quiz			
	Day 178	Review Lesson 28 and Lesson 28 Quiz			
	Day 179	Review Lessons 26–28			
	Day 180	Take **Examination 8 (Lessons 26–28)** Pages 279–280 • (TG)			
		Final Grade			

Worksheets

and

Laboratory Reports

for Use with

Physics

Complete the following problems based on the material from this chapter of your student book. You can use a calculator whenever necessary.

1. The only exceptions to natural laws are ____________________.
2. Natural laws ____________________.
   A. Are legal laws
   B. Are moral laws
   C. Came about gradually after the beginning of creation
   D. Worked from the very beginning of creation
3. Physics is the study of ____________________ ____________________.
4. Light was created ____________________.
   A. At the same time as the sun
   B. Before the sun
   C. After the sun
5. God's ____________________ is directed at the beginning of creation.
6. Natural law is a description of ____________________.
7. Natural laws ____________________.
   A. Are made to operate without God
   B. Vary from place to place
   C. Are created and maintained by God
8. Aristotle did not test his ideas with measurements and ____________________.
9. Aristotle concluded that heavier objects fell ____________________ than lighter objects.
10. The idea in question 9 was disproved by ____________________.
11. Aristotle taught that a thrown ball kept moving after leaving a person's hand because the air went behind the ball and ____________________ it.
12. Aristotle did not know about ____________________ and ____________________ that also play a role in movement.
13. A feather will fall slower than a rock because of __________ ____________________.
14. Galileo used lenses to make a ____________________ ____________________.
15. Galileo discovered ____________________ on the moon; ____________________ around the planet Jupiter; sun ____________________ and ____________________ of Venus which meant that Venus ____________________ around the sun. These observations went ____________________ the ____________________ of the church at that time.

16. Galileo was declared a ____________________ by the Inquisition court and placed under ____________________ ____________________.
17. ____________________ and ____________________ said that planets revolve around the sun, not the sun around ____________________.
18. Some today compare the opposition of Copernicus and Galileo to the opposition of ____________________ against ____________________.
19. Biblical doctrine must come from the ____________________ rather than ideas developed from ____________________.
20. Science begins with ____________________; forming ____________________ and using ____________________ to test the hypothesis.
21. A well supported hypothesis is a ____________________.
22. Experiments must be ____________________.
23. Hypotheses and theories are always being ____________________ as new insights are gained. This means that in science there are no ____________________.
24. The ____________________ of the ____________________ stay the same.
25. Deci- means ____________________; centi- means ____________________; milli- means ____________________ and kilo means ____________________.
26. There are ____________________ centimeters in a meter; ____________________ millimeters in a meter and ____________________ meters in a kilometer.
27. Volume can be found by multiplying the ____________________ × ____________________ × ____________________ of an object.
28. The basic unit of mass in the metric system is the ____________________, and the basic unit of time is the ____________________.
29. Density is defined as ____________________/____________________.
30. For Noah's Ark to float, it had to have a ____________________ below that of sea water.
31. The volume of a boat 3 feet wide, 10 feet long and 4 feet tall is ____________________ ft^3.
32. The volume of an object 2 m wide, 8 m long and 3 m tall is ____________________ m^3.
33. If the mass of the object in question 32 is 6 kg, its density is ____________________ $\frac{kg}{m^3}$.

Laboratory 1: Archimedes' Principle

Lab Notes:

REQUIRED MATERIALS

- ☐ Digital scale
- ☐ 12 cm × 12 cm piece of aluminum foil
- ☐ Duct tape
- ☐ Metric ruler
- ☐ Package of at least 25 metal washers
- ☐ Fine tip permanent marker

INTRODUCTION

Science is based upon observations, hypotheses, predictions to test the hypotheses, and determining whether the experiments support or reject the hypotheses. In this exercise, you will make some observations, make a hypothesis, and test it. Archimedes made observations like yours in this exercise. He noticed that some objects that were heavier floated while others that were lighter sank. Therefore, weight was not the only factor in determining whether something floated or not. Have you ever wondered why an aircraft carrier floats and a rock sinks? You have been making observations since you were born but probably have not wondered why they happened that way or tested them.

PURPOSE

This exercise provides experience in making observations and forming and testing a hypothesis.

PROCEDURE

Observe

1. Take a 12 cm × 12 cm (centimeter) piece of aluminum foil and mark it using the ruler as shown in the diagram. (*Diagram L1.1*)
2. Cut the aluminum foil as shown in the diagram below and fold up the sides so that the triangle-shaped pieces on the corners overlap. With pieces of duct tape, tape the overlapping corners so that you have a square shaped "boat" that is 4 cm × 4 cm at the base with the sides 4 cm tall. (*Diagram L1.2*)
3. Find the mass of your boat using the digital scale. Find the mass of a washer. The mass of each are in grams.
4. Mark the side of the aluminum boat 1 cm up from the bottom. (*Diagram L1.3*)

5. Place the aluminum boat in a body of water such as a bath tub or sink. Check it for leaks to be sure that no water enters the boat.

Question

6. Carefully add washers to the boat until it sinks down to the 1 cm mark but is still floating. Count the number of washers that you added and multiply that number by the mass of the washer found in step 3. Add the mass (grams) of the washers to the mass of the boat for the total mass. Find the density of the boat and washers by dividing the mass (grams) of the boat and washers by the volume of the boat. The volume of the boat is $4 \text{ cm} \times 4 \text{ cm} \times 4 \text{ cm} = 64 \text{ cm}^3$.

Research

7. Add additional washers to the boat until it sinks. Count the number of washers you added and multiply that number by the mass of the washer found in step 3. Add the mass (grams) of all the washers to the mass of the boat for the total mass. Find the density of the boat and washers after the boat sank. Divide the total mass of the boat and the washers (that made the boat sink) by its volume (64 cm^3).
8. Record your data and observations in your lab report.
9. The density of water is $\frac{1 \text{ gram}}{\text{cm}^3}$.

Hypothesis

10. Look at your data and observations and form an explanation (hypothesis) as to why the boat floated in step 6 and sank in step 7. Write out your hypothesis and how you came up with it. In other words, propose a reason why the boat floated in step 6 and sank in step 7.

Experiment

11. Now you need to test your hypothesis. A suggestion would be to repeat step 7 but add 1 less washer than in step 7 and observe whether it floats or sinks. Then find the density of the boat with its washers (as in step 7).

Analyze

12. How would this support or reject your hypothesis? You can use your creative juices to come up with other ways to test your hypothesis.

Conclusion

13. In your report, state how you tested your hypothesis and whether you supported it or rejected it and why.

1. Mass of aluminum boat ________ g
2. Mass of metal washer ________ g
3. ________ washers made the boat sink down to the 1 cm mark
4. The mass of the added washers

   ________ (number of washers) × ________ (mass of 1 washer) = ________ g

   Total mass = ________ g of washers + ________ g of boat = ________ g
5. Density of boat and washers

   $\dfrac{\text{\_\_\_\_\_\_\_\_ g of washers and boat}}{64 \text{ cm}^3}$ = ________ $\dfrac{\text{g}}{\text{cm}^3}$
6. ________ washers made the boat sink to the bottom

   ________ g of 1 washer × ________ washers = ________ g

   ________ g of washers + ________ g of boat = ________ g

   Density of washers and boat that sank to the bottom

   ________ g of washers and boat / 64 cm^3 = ________ $\dfrac{\text{g}}{\text{cm}^3}$
7. The density of water is 1.00 $\dfrac{\text{g}}{\text{cm}^3}$.
8. Write out your hypothesis as to why the boat floated in step 6 (of the instructions) and sank in step 7.
9. Explain how you tested your hypothesis.
10. Using complete sentences, did you support or reject your hypothesis?
11. Explain your reasoning in answering whether your hypothesis was supported or rejected.

Physics	Kepler's Laws of Planetary Motion	Day 56	Lesson 10 Worksheet 1	Name

Complete the following problems based on the material from this chapter of your student book.

1. ____________________ is the study of motion.
2. ____________________, by nature, always grows. God's revelation ____________________ changes.
3. The word *planet* is a Greek word for ____________________.
4. The ____________________ always appear grouped together in the same way in the night sky, while ____________________ appear to be in different positions at different times.
5. Aristarchus said that ____________________ was at the center of the universe.
6. Aristotle taught that ____________________ was at the center of the universe.
7. Describe Aristotle's view as to why the stars, planets, sun, and moon appeared to be where they were in the night sky.
8. Geocentric means earth-____________________. This view was made popular by ____________________.
9. The problems with the geocentric view are the ____________________ ____________________ ____________________ ____________________ ____________________ and the ____________________ motion of Mars, Jupiter, and Saturn.
10. Copernicus proposed a ____________________ model. This meant that the planets revolve around ____________________.
11. Copernicus explained the changing brightness of the planets by .
12. In the heliocentric model, the retrograde motion of Mars, Jupiter, and Saturn was explained by
13. If the earth revolved around the sun, some in Copernicus's day thought that we would ____________________ ____________________. This was later explained by a better understanding of ____________________.
14. The Roman Catholic church at the time of Copernicus held to a geocentric view. To think otherwise was ____________________ and punishable by death.
15. Some think of creation as only ____________________ rather than as divine ____________________.
16. The changes observed with the kinds of creation are controlled by ____________________ which had to have been ____________________ at the beginning of life.

17. As a teenager, Tycho Brahe observed a predicted ____________________ eclipse of the ____________________. This and other predictions that did not come out as well caused him to want to better understand the universe and make better predictions.
18. Tycho Brahe built a ____________________ with which he could accurately identify the positions of planets and stars.
19. The king of ____________________ built Brahe an ____________________ on an island to protect him.
20. Johannes Kepler organized Tycho Brahe's ____________________ but at first could not predict the positions of ____________________ any better than Ptolemy and Copernicus because he treated their orbits as ____________________.
21. When Kepler realized that the orbits of planets were ____________________, he made better predictions of their positions.
22. State Kepler's First Law of Planetary Motion.
23. State Kepler's Second Law of Planetary Motion.
24. State Kepler's Third Law of Planetary Motion.
25. Accurate predictions are evidence of ____________________ and numerical predictions are much greater ____________________.
26. ____________________ is a change in velocity, and planets must constantly change ____________________.
27. Planets stay in orbit around the sun because of their ____________________ ____________________.
28. A ____________________ is needed for acceleration.
29. The idea of the ____________________ of ____________________ was developed by Galileo.
30. The ____________________ Law of ____________________ was developed by Newton and explained why planets stayed in orbit around the sun.

Lab Notes:

Laboratory 10: Elliptical Orbits and Moon Phases

REQUIRED MATERIALS

- ☐ $8\frac{1}{2}'' \times 11''$ piece of cardboard
- ☐ Three $8\frac{1}{2}'' \times 11''$ pieces of plain paper
- ☐ 2 tacks
- ☐ 10″ long piece of string
- ☐ 2 helpers, a flashlight, and a darkened room

INTRODUCTION

Planets and the moon reflect light from the sun and do not emit their own light. As the moon revolves around earth, the side illuminated by the sun is seen as bright. During a full moon, the earth is between the moon and the sun and we see light reflected to us showing the full surface of the moon. During a new moon, the moon is between us and the sun and the light from the sun hitting the moon reflects to the sun and we do not see it. During a first quarter moon (when the moon is a quarter of the way around earth), we see the right side of the moon illuminated because that is the side of the moon that the sun shines on. During a third (or last) quarter moon (when the moon is three quarters of the way around earth), we see the left side of the moon illuminated because that is the side of the moon the sun is shining on. As the moon revolves around earth, we are seeing light reflected from the part of the moon the sun shines on. While this is happening, the same side of the moon always faces us. This is because the moon revolves around earth at precisely the same rate that it rotates on its axis. If the rate of revolution and rotation were even slightly different, after a few thousand years we would be seeing a different part of the moon (*Diagram L10.2*).

PURPOSE

This exercise is to demonstrate the nature of an elliptical orbit and the phases of the moon.

PROCEDURE

Observe

1. Cut an $8\frac{1}{2}$“ × 11” piece of cardboard or stiff paper. Lay a piece of unlined paper onto the cardboard. Cut a piece of string 10” long. Place a tack in the middle of the paper. Tie the two ends of the string together to make a loop. Place the string loop over the tack and a pencil in the

other end of the string loop. With the string loop attached to the tack, draw a circle around the tack by moving it around the tack (*Diagram L10.3*).

2. Place another sheet of paper on the cardboard. Instead of the tack, place 2 tacks 1 inch apart in the middle of the paper. Place the string loop over the two tacks and draw a small ellipse around the tacks. This is like a planetary orbit around the sun, where the sun is represented by one of the tacks. Notice that your ellipse has a point closer to the "sun" and a point farther from it.

Question

3. Repeat step 2 except this time place the tacks 3 inches from each other. Draw out the ellipse around these foci. Notice that this a much narrower ellipse.

4. If you can, go outside tonight and see if you can see the moon. If the sky is relatively clear and the moon has not risen yet, check every night for a while until it is visible. As an alternative, you can go online and ask the question "What does the moon look like tonight?"

Research

5. Describe and draw the moon as you see it. After a week, go out and describe and draw the moon again. Do this 2 more times. Describe the phase of the moon for each evening that you observe it. This part of the lab will take at least a month to complete.

Hypothesis

6. The moon has phases which is evidence that it revolves around the earth. You can also see phases of the planet Venus if you use binoculars or a telescope. This is because Venus revolves around the sun closer to the sun.

Experiment

7. Go into a dark room with 2 helpers. Stand in the middle of the room (you are earth). Have another person (the moon) walk in a circle around you, rotating so that the front of the person always faces you. The third person (the sun) is to stay on one side of the room and shine a flashlight on the person going around you. It is important that the light always come from the same direction. Have the rotating person go to new moon, first quarter moon, full moon, and third quarter moon position.

Analyze

8. Describe how the light shines on the rotating person at each position.

Conclusion

9. This is how the phases of the moon are produced.

1. Drawing of a circle

2. Drawing of an ellipse with the foci close together

3. Drawing of an ellipse with the foci farther apart

4. Drawing of the moon on the first night and its phase

5. Drawing of the moon on the second night (week later) and its phase

6. Drawing of the moon on the third night (2 weeks later) and its phase

7. Drawing of the moon on the fourth night (3 weeks later) and its phase

8. Describe how the light shown on your helper and each of the “phases of the moon” that were illustrated.

Complete the following problems based on the material from this chapter of your student book. You can use a calculator whenever necessary.

1. An _____________ _____________ is the flow of electric charge. It is indicated as the flow of _____________ charges.
2. An _____________ circuit is broken, so current cannot flow through it.
3. A _____________ circuit is complete, allowing an electric current to flow through it.
4. A bulb is called a _____________.
5. Longer wires have more _____________ than shorter wires.
6. Electrical resistance is measured in units of _____________, which is symbolized by the letter _____________.
7. State Ohm's Law.
8. ΔV means a change in _____________ or a _____________ in voltage.
9. A _____________ current flows in one direction.
10. An _____________ current flows back and forth.
11. What is the current of a circuit with a $1\frac{1}{2}$ V battery and a 20Ω bulb?
12. Bulbs connected in a row with a battery are connected in a _____________.
13. Bulbs connected separately to the same battery are in _____________.
14. What is the total voltage of 3 batteries of $1\frac{1}{2}$ V each connected in series?
15. What is the total resistance of 3 15Ω bulbs connected in series?
16. What is the current of the circuit with the batteries in question 14 and the bulbs in question 15?
17. What is the total resistance of 3 15Ω bulbs in parallel?
18. What is the current of the circuit with the batteries in question 14 and the bulbs in question 17?
19. What is the current of a circuit with 4.5 V battery and a 15Ω bulb?
20. The voltage and current is measured with a _____________.
21. What is the total resistance of the bulbs 10Ω, 10Ω, and 20Ω in parallel?

22. Place the leads of the meter in _____________ with the bulb to measure the _____________ _____________.
23. A voltmeter has a _____________ resistance to keep it from drawing current away from the resistor.
24. An ammeter is used in _____________ to measure electric current with the _____________ pole of the battery.
25. If you want to measure the flow of water in a stream, place the lower _____________ in the _____________.
26. Electric power is measured in units of _____________/_____________, which are _____________.
27. What is the power used by the battery and bulb in question 19?
28. What is the power used by the batteries and bulbs in question 16?

Laboratory 20: Electric Circuits

REQUIRED MATERIALS

- ☐ Insulated copper wire
- ☐ Switch
- ☐ 3.7 V bulbs (2)
- ☐ Bulb holder (2)
- ☐ AA battery holder
- ☐ AA batteries (2)
- ☐ Multimeter

Purpose

This lab exercise is to provide experience setting up an electrical circuit with bulbs in series and parallel and measuring their voltage drops and current.

Procedure

Observe

1. Using lengths of the insulated copper wire (at least 1 to 2 inches long per section), connect the battery holder with 2 AA batteries, the switch, and a bulb holder with a 3.7V bulb. Connect the wires to the screws on each of the different parts (*Diagram L20.1*).

   Test your circuit by closing the switch to be sure that the bulb shines. Then open the switch so that you do not drain the batteries.

   For all of these procedures, attach the red wire of the multimeter to the outlet on the meter marked $V\Omega m$A, and the black wire to the outlet on the meter marked COM. When testing the circuit, the red lead from the meter is closest to the positive poles of the batteries.

Question

2. As you work through this lab, describe what you are doing and your results to your teacher. Record your results in your report. Describe the direction of current flow and the direction of electron flow.

3. Disconnect the wire connected to the bulb holder and connect the red lead to the wire going to the battery holder and the black lead to the bulb holder. Set the dial on the meter to 200mA (the maximum reading on the meter is 200 mA or 0.2 A). If the reading on the meter exceeds 200 mA, set the dial to 10 A. This means that

Lab Notes:

the maximum reading is 10 A. Close the switch and read the current from the meter. Record this value. Open the switch (*Diagram L20.2*).

Research/Hypothesis

4. Remove the multimeter from the circuit and restore the wire connections as before. Turn the dial on the multimeter to DCV 20 V. Place the red lead of the multimeter on the side of the bulb holder close to the positive poles of the batteries and the black lead on the opposite side of the bulb holder. Close the switch so that the bulb glows and read the voltage from the multimeter. Record this value. Open the switch (*Diagram L20.3*).

Experiment

5. Add a second bulb holder with a bulb into the circuit in series with the first bulb as shown in this diagram (*Diagram L20.4*).

6. Repeat step 2 with 2 bulbs in series instead of 1 bulb. Record the value of the current with two bulbs (*Diagram L20.5*).

7. Repeat step 3 with 2 bulbs in series instead of 1 bulb. Measure the voltage drop of each bulb separately and together (*Diagram L20.6*).

8. Rewire the circuit so that you have 2 bulbs in parallel instead of series (*Diagram L20.7*).

9. Repeat step 2 with 2 bulbs in parallel instead of 1 bulb. Record the value of the current with two bulbs connected in parallel (*Diagram L20.8*).

10. Repeat step 3 with 2 bulbs in parallel instead of 1 bulb. Measure the voltage drop of each bulb separately (*Diagram L20.9*).

Analyze

11. From the current and voltage of the circuit in step 2, calculate the resistance of the bulb. Use Ohm's Law $R = \frac{V}{I}$. Show your work in your report.

12. From your results in this lab exercise, describe the meaning of the terms *current*, *voltage*, and *resistance*. How did placing the bulbs in series affect the current?

Conclusion

13. How did placing the bulbs in parallel affect the current?

1. In step 1, did the bulb glow? Describe with a complete sentence.

2. What is the measured current with 2 AA batteries and 1 bulb?

3. What is the measured voltage drop with 2 AA batteries and 1 bulb?

4. Did the 2 bulbs in series glow? How does their brightness compare to the 1 bulb in step 1?

5. What is the measured current with 2 AA batteries and 2 bulbs in series?

6. What is the measured voltage drop with 2 AA batteries and 2 bulbs in series?

7. Did the 2 bulbs in parallel glow? How does their brightness compare to the 1 bulb in step 1?

8. What is the measured current with 2 AA batteries and 2 bulbs in parallel?

9. What is the measured voltage drop of each bulb with 2 AA batteries and 2 bulbs in parallel?

10. Calculate the resistance of one of the bulbs in parallel (*Hint*: Use Ohm's Law). Show your work.

11. Measure the resistance of one of the bulbs in parallel. Set the dial on the multimeter to 10A and place the leads on the bulb holder as you did to test for the voltage drop. Describe your result. How does it compare to your calculated value? If it is a little lower than your calculated value, it may be due to internal resistance in the batteries and the wires.

12. Describe what is meant by the terms current, voltage, and resistance. How did placing the bulbs in series affect the current? How did placing the bulbs in parallel affect the current?

Match the correct answers

______	1. Natural laws	A. heavier objects fall faster than lighter objects
______	2. Galileo	B. used to create natural laws
______	3. Exceptions to natural laws	C. discovered craters on the moon
______	4. Aristotle	D. a description of observations
______	5. God's wisdom	E. miracles

______	6. Aristotle	A. planets revolve around the sun
______	7. Theory	B. science begins with this
______	8. Copernicus	C. rock falls faster than a feather
______	9. Caused by air resistance	D. well supported hypothesis
______	10. Observations	E. philosopher

______	11. Floats	A. must be repeatable
______	12. Experiments	B. can be supported but cannot be proven to be true
______	13. Density	C. $\frac{1}{1{,}000}$
______	14. Hypothesis	D. mass/volume or $\frac{\text{mass}}{\text{volume}}$
______	15. Milli-	E. density below density of water

E	*Physics*	Scope: Chapters 1–4	Day 25	Exam 1	Total score: ____ / 30 = ____ %	Name

You may use a calculator when taking this examination.

Match the correct answers

_____ 1. Aristotle

_____ 2. Observations

_____ 3. Galileo

_____ 4. Hypothesis

_____ 5. Natural laws

A. discovered craters on the moon

B. can be supported but cannot be proven

C. heavier objects fall faster than lighter objects

D. a description of observations

E. science begins with this

_____ 6. Density

_____ 7. Centi-

_____ 8. Milli-

_____ 9. Vectors

_____ 10. Copernicus

A. planets revolve around the sun

B. $\frac{1}{1{,}000}$

C. $\frac{1}{10}$

D. diagram quantity and direction

E. mass/volume or $\frac{\text{mass}}{\text{volume}}$

Circle the correct answers

11. If you travel 72 $\frac{\text{miles}}{\text{hour}}$ from Los Angeles to Phoenix, 72 $\frac{\text{miles}}{\text{hour}}$ is the ______________.
    A. Acceleration
    B. Average velocity
    C. Average speed
    D. Instantaneous velocity
12. We know that a falling object (without air resistance) accelerates at g = ______________.
    A. 32 $\frac{\text{m}}{\text{s}^2}$
    B. 6 $\frac{\text{m}}{\text{s}^2}$
    C. 12.2 $\frac{\text{m}}{\text{s}}$
    D. 9.8 $\frac{\text{m}}{\text{s}^2}$
13. ________________ said that force did not have to be constantly applied to an object to keep it moving.
    A. Kepler
    B. Einstein
    C. Galileo
    D. Newton

14. An increase of velocity by 30 $\frac{m}{s}$ in 3 seconds is an acceleration of ____________.

   A. 7.8 $\frac{m}{s}$

   B. 10 $\frac{m}{s^2}$

   C. 30 $\frac{m}{s^2}$

   D. 90 $\frac{m}{s}$

15. The combination of 2 or more vectors is ___________________.

   A. Not a vector

   B. A resultant

   C. Acceleration

   D. Not possible

Match the correct answers

_____	16. Newton's 1st Law of Motion	A.	$F = ma$
_____	17. Newton's 2nd Law of Motion	B.	metric unit of mass
_____	18. Newton's 3rd Law of Motion	C.	inertia
_____	19. kg	D.	a balloon with air rushing out
_____	20. Newton	E.	unit of force

_____	21. 1 $\frac{m}{s^2}$	A.	force needed to accelerate 4 kg at 10 $\frac{m}{s^2}$
_____	22. 1 pound	B.	changes in direction
_____	23. 40 N	C.	going from 0 $\frac{m}{s}$ to 5 $\frac{m}{s}$ in 5 seconds
_____	24. $-1 \frac{m}{s^2}$	D.	going from 10 $\frac{m}{s}$ to 5 $\frac{m}{s}$ in 5 seconds
_____	25. Acceleration	E.	4.4 N

Circle the correct answers

26. What is the total upward acceleration of a rocket going straight up when its engine provides an acceleration of 20 $\frac{m}{s^2}$?

   A. 9.8 $\frac{m}{s^2}$

   B. 10.2 $\frac{m}{s^2}$

   C. 15 $\frac{m}{s^2}$

   D. 0 $\frac{m}{s^2}$

27. If you throw a baseball at 70 $\frac{\text{miles}}{\text{hour}}$ toward the west and the wind blows back at you at 10 $\frac{\text{miles}}{\text{hour}}$, what is the total velocity of the baseball?

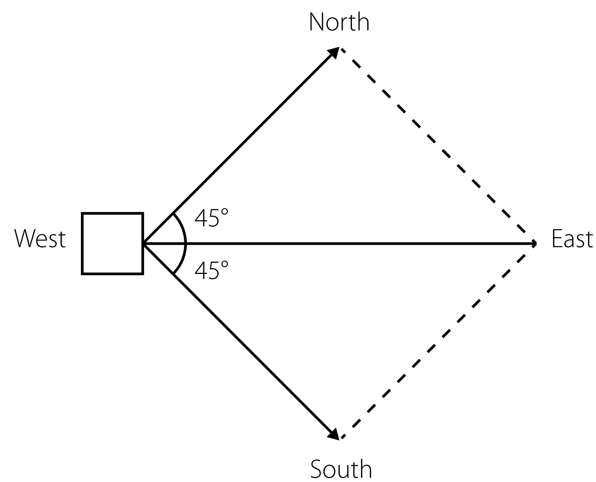
A. 70 $\frac{\text{miles}}{\text{hour}}$

B. 60 $\frac{\text{miles}}{\text{hour}}$

C. 80 $\frac{\text{miles}}{\text{hour}}$

D. 140 $\frac{\text{miles}}{\text{hour}}$

Use this diagram for questions 28 and 29.



28. The resultant force is ______________________.

A. 3 N

B. 6 N

C. 2 N

D. 8.4 N

29. The resultant force is pulling toward the ___________.

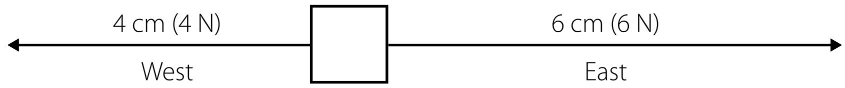
A. East

B. North

C. West

D. South

Use this diagram for question 30.



30. The resultant force is __________________.

    A. 2 N east

    B. 4 N east

    C. 6 N west

    D. 8 N west

Physics Worksheet and Lab Report Answer Keys

Lesson 1
Worksheet

1. Miracles
2. D
3. Natural laws
4. B
5. Wisdom
6. Observations
7. C
8. Experiments
9. Faster
10. Galileo
11. Pushed
12. Momentum, inertia
13. Air resistance
14. Refracting telescope
15. Craters, 4 moons, spots, phases, orbited, against, teachings
16. Heretic, house arrest
17. Copernicus, Galileo, earth
18. Creation, evolution
19. Bible, philosophy
20. Observations, hypotheses, experiments
21. Theory
22. Repeatable
23. Replaced, absolutes
24. Truths, Bible
25. $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1{,}000}$, 1,000
26. 100, 1,000, 1,000
27. Length, width, height (in any order)
28. Gram, second
29. Mass/volume or $\frac{\text{mass}}{\text{volume}}$
30. Density
31. 120
32. 48
33. $\frac{1}{8}$

Lesson 1
Lab Report

Each lab report is worth a possible 20 points. A sample lab report is provided for labs 1 and 2. These will give the student a good idea as to how to prepare the lab report. The rest of the lab reports are to be completed in a similar manner.

The responses to items 1 through 6 will be different for the student than in the sample lab report.

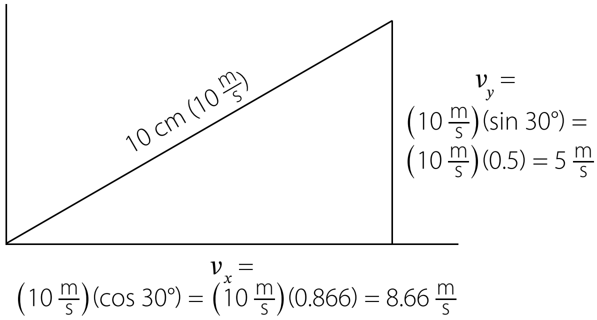
Award a possible **12 points** for completing the procedures for items 1–6 and correctly following directions.

Award a possible **8 points** for completing items 8–11. The responses must be in complete sentences. Are the answers clear? Are the answers consistent with their measurements recorded in items 1–6? The sample lab report provides an example of what their responses should look like. It is okay for the student to look at the sample lab report because this exercise is meant to be a learning experience rather than a quiz.

Lesson 2
Worksheet

1. Speed, velocity, acceleration, force, Newton's 3 Laws of Motion, energy, work
2. Force, inclined plane
3. Heavier, lighter, velocity
4. Displacement
5. speed
6. Instantaneous
7. velocity
8. Vector, direction
9. Scalar, direction
10. Change in
11. Speed
12. Velocity
13. 32 $\frac{\text{m}}{\text{s}}$

13. $v_y = 5\,\frac{m}{s}$ and $v_x = 8.66\,\frac{m}{s}$



14. $t = \frac{v_o}{g} = \frac{10\,\frac{m}{s}}{9.8\,\frac{m}{s^2}} = 1.02\text{ s}$

15. $\frac{5\,\frac{m}{s} + 0\,\frac{m}{s}}{2} = 2.5\,\frac{m}{s}$

    $d = v_{\text{average}}t = (2.5\,\frac{m}{s})(1.02\text{ s}) = 2.55\text{ m}$

16. $\frac{8.66\,\frac{m}{s} + 0\,\frac{m}{s}}{2} = 4.33\text{ m}$

    $d = v_{\text{average}}t = (4.33\,\frac{m}{s})(1.02\text{ s}) = 4.42\text{ m}$

17. The pitcher puts a counterclockwise spin on the ball when it is released. As the ball moves by the batter, its spin creates a slight vacuum on the side of the ball opposite the batter which pulls the ball away from the batter.
18. The escape velocity is when as the velocity of the spacecraft decreases, it remains great enough to keep going away from earth's gravitational pull.
19. $\frac{1}{5^2} = \frac{1}{25}$
20. $\frac{1}{10^2} = \frac{1}{100}$

Lesson 9
Lab Report

1. Parts 1, 2, and 3 of the report are based upon the student's measurements. The distance measured in cm (centimeters) needs to be converted to meters. There are 100 cm in a meter, so 6 cm is 0.06m.
2. The answers to parts 4 and 5 of the report are meters divided by time to give meters/second.
3. Award a possible **4 points** for parts 1–5 of the report. Base the grade upon neatness and accuracy.
4. The vector diagram in part 6 of the lab report should be like the one given in step 4 of the procedure instructions in the text. Parts 7 and 8 are based upon the student's measurements from the vector diagram. Award a possible **4 points** for parts 6–9 of the report.
5. For part 9 of the lab report, the sine and cosine of the angle are found using a calculator. Enter the angle (for example 45 if the angle is 45°) and then the sine button for the sine and the cosine button for the cosine.
6. Part 10 of the lab report is the sine of the angle times the length of the diagonal on the vector diagram, which should be close to the length of the vertical line. The measurements from the vector diagram are approximate and the use of the sines and cosines are more precise.
7. Part 11 of the lab report is the cosine of the angle times the length of the diagonal on the vector diagram, which should be close to the length of the horizontal line. Award a possible **4 points** for parts 8–10 of the report.
8. The results in parts 11 and 12 of the lab report are based upon the student's observations.
9. The conclusions in part 13 of the lab report are based upon the student's expectations based upon the material in chapter 9 of the text. A ball thrown at greater than 45° and less than 45° should not go as far as a ball thrown at 45°. If the results do not come out as expected, have the student repeat step 9 of the lab procedure. Straight up is 90° and horizontal is 0°, and 45° is right in between. This can be approximated when throwing the ball. Award a possible **8 points** for parts 12–14 of the lab report.

The lab report is worth a possible **20 points**.

Chapter 10 — Kepler's Laws of Planetary Motion

1. Mechanics
2. Science, never
3. Wanderer
4. Stars, planets
5. The sun
6. Earth
7. Aristarchus said that 4 spheres circled the earth. The outer sphere had the stars on it; the next sphere closer to earth had the planets on it; the third sphere had the sun; and the fourth sphere

had the moon. As the sphere rotated around earth, the stars, planets, sun, and moon appeared to move across the sky.

8. Centered, Ptolemy
9. Changing brightness of the planets, retrograde
10. Heliocentric, the sun
11. Those that are closer to earth are brighter than those that are farther away
12. The planets closer to the sun catch up with and pass the planets farther away, making them appear to go backwards.
13. Fly off the earth, gravity
14. Heresy
15. Opinions, revelation
16. DNA, created
17. Eclipse, sun
18. Quadrant
19. Denmark, observatory
20. Data (or measurements), planets, circles
21. Ellipses
22. Kepler's First Law of Planetary Motion was that planets orbit around the sun in ellipses instead of circles.
23. The Second Law of Planetary Motion was that planets go faster when they are closer to the sun and slower when they are farther from the sun. Another way to state it is that the radius vector from the sun to a planet sweeps out equal areas in equal amounts of time.
24. The Third Law of Planetary Motion is that the radius of revolution of a planet cubed divided by the period (T, the time it takes a planet the orbit the sun) squared is the same for every planet except for Pluto.
25. Design, evidence
26. Acceleration, direction
27. Centripetal acceleration
28. Force
29. Acceleration, gravity
30. Universal, Gravity

Lesson 10
Lab Report

1. Parts 1–3 together are worth a possible **5 points**. These involve the student following directions and drawing the images of a circle and ellipses using a piece of string, tacks, and a pencil. This exercise helps to give the student a better image of the shape of the planetary orbits.
2. Part 4 involves observing the moon on 4 different evenings each a week apart. If the sky is not favorable to observations (cloudy) an alternative is to go online and type in "What does the moon look like tonight?" The observations may be between some of the phases. That is okay. The report is to include a drawing of the moon and an identification as to which phase is represented. This exercise takes a month to complete. This exercise is worth a total of **10 points** possible.
3. Part 5 is a simulation of the revolution of the moon around earth causing the phases as seen from earth. Grade this exercise by how well the student followed directions and if the student was able to see how the phases of the moon are formed. The phases are described in the introduction to this lab. This part of the report is worth a possible **5 points**, giving a total of 20 points possible for the lab.

Chapter 11 — Heat Energy

1. Thermal, kinetic, Rudolf Clausius
2. Subjective
3. Temperature, expanded, contracted
4. Fahrenheit, 32°, 212°
5. Celsius, 0°, 100°, metric
6. 0
7. 20°
8. 212
9. 59°
10. BTU, British Thermal Unit
11. Hot, cold, thermal equilibrium
12. Heat capacity, Calorie
13. 5
14. Joule

27. Mirage, water

Lesson 18
Lab Report

Assign a total possible 20 points for this lab report. Steps 5 and 6 together are worth **5 points** and the other steps are worth **3 points** each. The answers are to be in complete sentences. Observe the student going through the procedures and give encouragement as these procedures take patience. This is especially true for steps 5 and 6. This is the nature of optics. Be sure that the student makes all observations and explanations. Can you visualize the observations from the student's descriptions? Are the explanations reasonable?

Chapter 19 — Dispersion of Light and Reflection

1. Refraction, slows
2. Slower
3. Blue
4. Indices, refraction
5. Prisms, rainbows
6. Double reflection, raindrops
7. Reflection, refraction, diffraction (in any order)
8. Narrow
9. Iridescence
10. Colors, interference, fish, bird
11. Planes
12. Incident, normal, reflection, normal, Law, Reflection
13. Diffuse reflection
14. Magnification
15. Focal point, virtual magnified
16. Image, object, focal length
17. $\frac{1}{f} - \frac{1}{o}$
18. $-\frac{i}{o}$
19. Diverge
20. Red
21. Blue
22. Critical angle
23. As heavy, color aberrations
24. Radio wave, infrared, ultraviolet, X, ray, gamma, ray
25. If o is 4 cm and f is 8 cm, $\frac{1}{o} = \frac{1}{4}$ and $\frac{1}{f} = \frac{1}{8}$

    $\frac{1}{f} - \frac{1}{o} = \frac{1}{8} - \frac{1}{4} = \frac{1}{8} - \frac{2}{8} = -\frac{1}{8}$

    $\frac{1}{i} = -\frac{1}{8}$

    $i = -8$ cm (it is negative because it goes into the mirror.)

    The magnification of the image is $-\frac{i}{o} = -\frac{-8}{4} = 2$. The image is magnified 2×.

Lesson 19
Lab Report

Assign a total possible 20 points for this lab report. Assign a possible **5 points** to each of steps 1 and 2. Assign a possible **2 points** to each of steps 3, 4, 5, and 6. Assign a possible **2 points** for calculating the magnification of the image in step 4. Grade the exercises based on how well the student follows directions and how clearly the student describes the observations and answers the questions. It is permissible for the student to look at the examples of calculating the magnification of the concave mirror. The answer depends upon the focal length of the mirror (which is 20 centimeters) and the measured distance from the object to the mirror. Check the math for accuracy. It is quite okay to get some help with this one.

Chapter 20 — Electric Circuits I

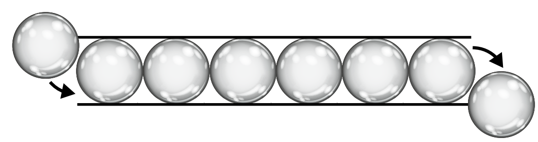
1. Electric current, positive
2. Open
3. Closed
4. Resistor
5. Resistance
6. Ohms, Omega
7. $I = \frac{V}{R}$ and current $= \frac{\text{voltage}}{\text{resistance}}$
8. Voltage drop
9. Direct
10. Alternating

11. $I = \frac{V}{R} = \frac{1.5\ V}{20\ \Omega} = 0.075\ A$
12. Series
13. Parallel
14. $1\frac{1}{2}\ V + 1\frac{1}{2}\ V + 1\frac{1}{2}\ V = 4\frac{1}{2}\ V$
15. $15\ \Omega + 15\ \Omega + 15\ \Omega = 45\ W$
16. $I = \frac{V}{R} = \frac{4.5\ V}{45\ \Omega} = 0.1\ A$ (amps)
17. $\frac{1}{R_{Total}} = \frac{1}{15}\ \Omega + \frac{1}{15}\ \Omega + \frac{1}{15}\ \Omega = \frac{3}{15}\ \Omega = 0.2\ \Omega$ and
    $R_{Total} = \frac{1}{0.2}\ \Omega = 5\ W$
18. $I = \frac{V}{R} = \frac{4.5\ V}{5\ \Omega} = 0.9\ A$
19. $I = \frac{V}{R} = \frac{4.5\ V}{15\ \Omega} = 0.3\ A$
20. Multimeter
21. $\frac{1}{R_{Total}} = \frac{1}{10}\ \Omega + \frac{1}{10}\ \Omega + \frac{1}{20}\ \Omega = \frac{2}{20}\ \Omega + \frac{2}{20}\ \Omega + \frac{1}{20}\ \Omega$
    $= \frac{5}{20}\ \Omega = 0.25\ \Omega$ and $R_{Total} = \frac{1}{0.25}\ \Omega = 4\ W$
22. Parallel, voltage drop
23. Large
24. Series, positive
25. Meter, stream
26. Joules, second, watts
27. $P = I^2R = (0.3\ A)^2(15\ \Omega) = 1.35\ W$
28. $P = I^2R = (0.1\ A)^2(45\ \Omega) = 0.45\ W$

Lesson 20
Lab Report

Assign a total possible 20 points for this lab report. Assign a possible **1 point** for steps 1 and 2 and **2 points** for each of the steps from step 4 through step 12. Grade the exercises based on how well the student follows directions and how clearly the student describes the observations and answers the questions. It is quite okay to get some help with this one. The main purpose of this lab is to gain experience with setting up electric circuits and measuring them.

Chapter 21 — Electric Circuits II

1. Alternating
2. Root mean square, RMS
3. Circuit breaker
4. Diagram 21-1
5. Electric
6. 15 mA
7. Ground
8. Positive, negative
9. Rising, falling
10. Positive
11. Leader
12. Insulator, conductor
13. Nitrates
14. Lightning
15. Current
16. $I = \frac{P}{\Delta V} = \frac{90\ W}{110\ V} = 0.82\ A$
17. $R = \frac{\Delta V}{I} = \frac{110\ V}{0.82\ A} = 134\ W$
18. $I = \frac{P}{\Delta V} = \frac{1100\ W}{110\ V} = 10\ A$
19. $R = \frac{\Delta V}{I} = \frac{110\ V}{10\ A} = 11W$
20. 
21. Charges build up on the plates until they reach a certain amount and they jump across the insulator gap.
22. They store energy and act as timing devices.
23. Integrated circuits, microchips
24. Semiconductors
25. Metals, non-metals
26. Electrons, negative
27. Holes, positive
28. n-type, p-type
29. Rectifier
30. Diode
31. Transistor, amplify, switch
32. Superconductors, below, indefinitely

Physics Quiz Answer Keys

Lesson 1
Physics, Wisdom, and Science

1. D
2. C
3. E
4. A
5. B
6. E
7. D
8. A
9. C
10. B
11. E
12. A
13. D
14. B
15. C

Lesson 2
Speed, Velocity, and Acceleration

1. C
2. C
3. B
4. A
5. B
6. C
7. A
8. B
9. E
10. D
11. D
12. E
13. A
14. B

Lesson 3
Force and Newton's Three Laws of Motion

1. C
2. E
3. A
4. D
5. B
6. E
7. A
8. D
9. C
10. B
11. D
12. C
13. A
14. E
15. B

Lesson 4
Vectors

1. B
2. D
3. A
4. C
5. B
6. C
7. A
8. C
9. A
10. C
11. D
12. C
13. A
14. C
15. C

Physics Exam Answer Keys

Exam 1 (Lessons 1–4)

1. C
2. E
3. A
4. B
5. D
6. E
7. C
8. B
9. D
10. A
11. B
12. D
13. C
14. B
15. B
16. C
17. A
18. D
19. B
20. E
21. C
22. E
23. A
24. D
25. B
26. B
27. B
28. D
29. A
30. A

Exam 2 (Lessons 5–8)

1. B
2. A
3. D
4. B
5. C
6. D
7. E
8. A
9. C
10. B
11. A
12. C
13. D
14. E
15. B
16. C
17. E
18. B
19. A
20. D
21. E
22. B
23. A
24. C
25. D
26. A
27. C
28. A
29. A
30. D

Exam 3 (Lessons 9–12)

1. C
2. A
3. C
4. D
5. B
6. A
7. D