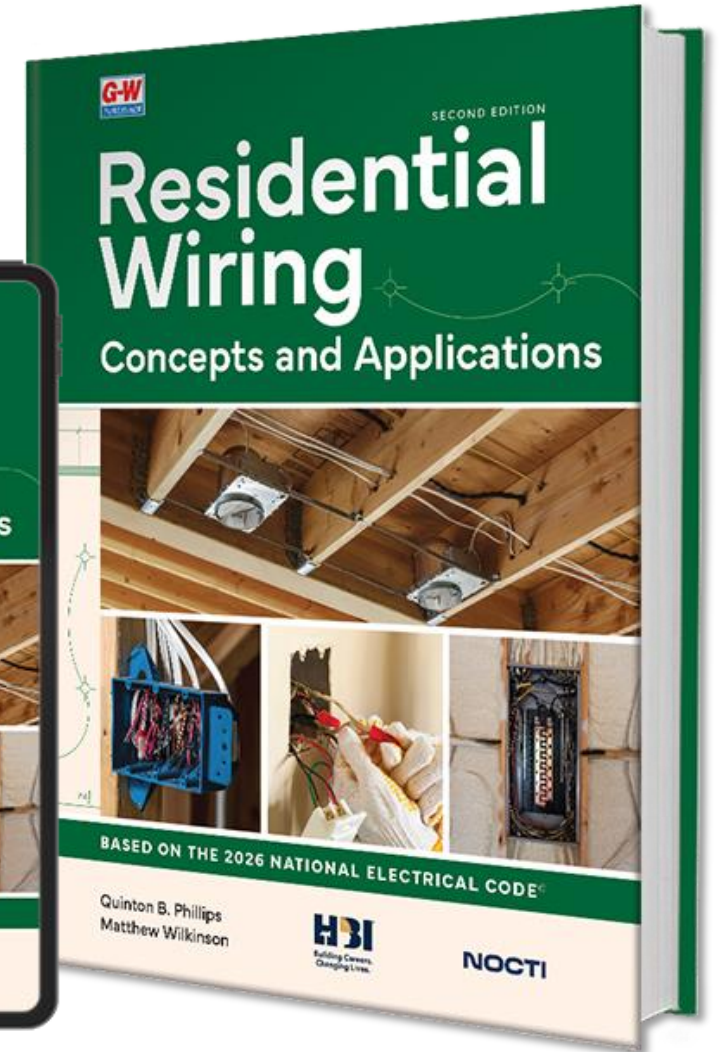
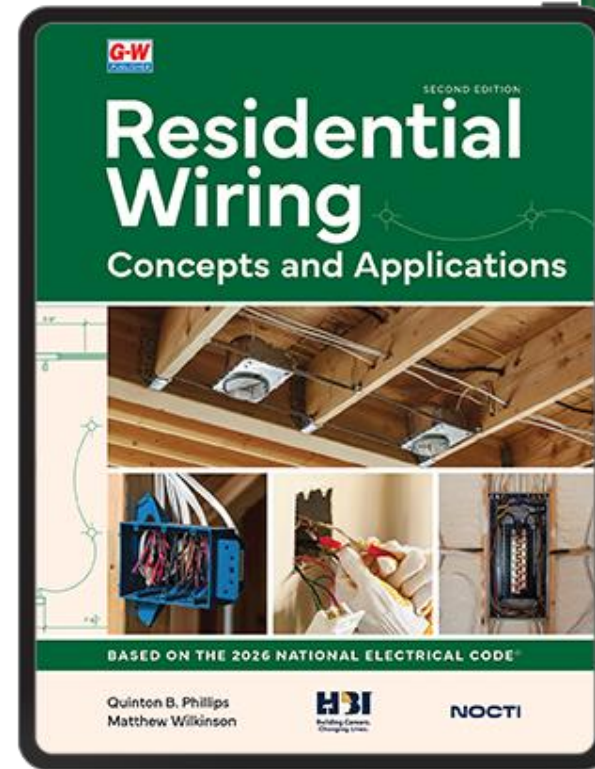


G-W
PUBLISHER



*Residential Wiring Concepts
and Applications*



Residential Wiring Concepts and Applications: Lesson Plan

Instructor: _____ Date: _____
Course: _____ Unit: _____

Chapter 6: Electrical Test Equipment

Learning Outcomes

- 6.1 Summarize typical meters and their uses in residential wiring.
 - Voltage Testers and Meters
- 6.2 Describe the uses of multimeters in residential wiring.
 - Multimeters
- 6.3 Discuss the typical meters used for measuring current in an electrical circuit.
 - Ammeters
- 6.4 Identify common plug-in testers used by residential electricians.
 - Plug-in Testers
- 6.5 Explain how to conduct a continuity test on an electrical circuit.
 - Continuity Testing

Sparking Discussion
How does a foundation in electrical theory aid in understanding electrical test equipment readings?

Standards
The following *Home Builders Institute House Wiring Basic* standards are addressed in this chapter:

- Electrical Codes and Blueprints
- Basic Concepts of Electricity

The following *Home Builders Institute House Wiring Advanced* standards are addressed in this chapter:

- Safety, Tools and Equipment
- Codes and Blueprints
- Basic Concepts

The following *Home Builders Institute Pre-Apprentice* standards are addressed in this chapter:

- Safety, Tools & Equipment
- Electrical Trim-Out and Troubleshooting

The following *NOCTI Electrical Construction* standards are addressed in this chapter:

- Meters, Measurements, and Testing

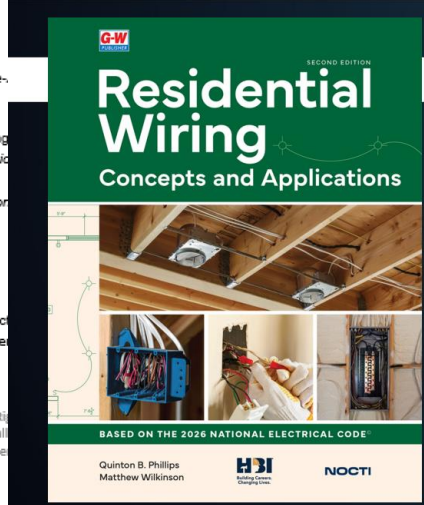
The following *NOCTI Electrical Occupations* standards are addressed in this chapter:

- Tools

Instructional Resources


- Textbook/eBook: Chapter 6
- Instructor Resources: Chapter 6 Instructor Resources
- Instructor Resources: Chapter 6 Answer Keys
- Electrical Wiring Videos:

1
Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without permission in writing from Goodheart-Willcox Co., Inc. or as permitted by U.S. copyright law. Such materials are not accessible by the general public.

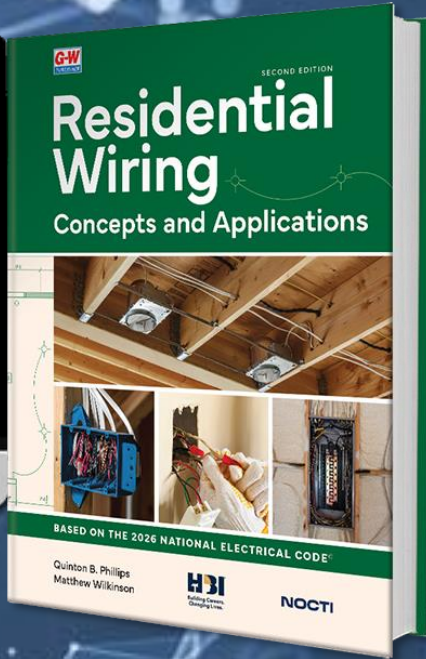
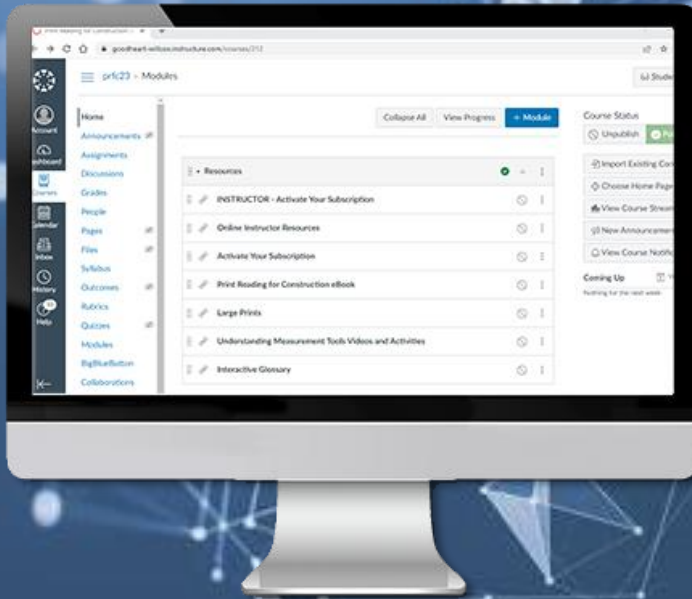


Presentations for PowerPoint

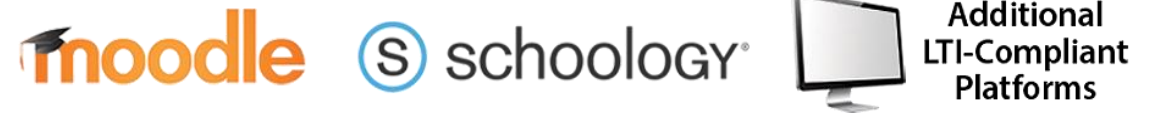
Residential Wiring Concepts and Applications



Lesson Plans, PowerPoint Presentations, and Answer Keys



Print • Digital • Bundle Options Available



LMS and CMS Integration Easy Navigation

6: E-Flash Cards

Term (1 of 13)

ammeter

Previous Remove Next

E-Flash Cards & Vocabulary Practice

Definition (1 of 13)

An electrical test instrument used to measure current in a circuit.

Previous Remove Next

6: Vocabulary Game

Select a point value. Choose the term that matches the definition.

Score: 0

<input checked="" type="radio"/> 100	<input type="radio"/> 100	<input type="radio"/> 100	<input type="radio"/> 100
<input type="radio"/> 200	<input checked="" type="radio"/> 200	<input type="radio"/> 200	<input type="radio"/> 200

Definition: An electrical testing device that reads and displays the precise amount of voltage that is present in a circuit.

- receptacle tester
- voltmeter
- circuit breaker finder
- ~~solenoid voltage tester~~

Check Answer

Interactive Activities

Residential Wiring Concepts and Applications: Activity 6-1

Name:
Date:
Class:

Chapter 6: Electrical Test Equipment

Activity 6-1

Chapter Review Questions

Complete the following questions after carefully reading the corresponding

- True or False?* A solenoid voltage tester does not need to be connected to energized components to get a reading. (6.1)
Answer:
- Ghost voltages are a drawback of _____. (6.1)
A. analog voltmeters
B. solenoid voltage testers
C. digital voltmeters
D. non-contact voltage testers
Answer:
- All measurements on a multimeter are made using test _____. (6.2)
Answer:
- Which of the following measurements should *not* be taken on an energized circuit? (6.2)
A. Continuity
B. Current
C. Voltage
D. You should never take measurements on an energized circuit.
Answer:
- True or False?* The clamp meter is a safer alternative to the in-line ammeter. (6.2)
Answer:

1

Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. You may not reproduce, create derivative works from, utilize any AI technology with respect to, or allow unauthorized access to, any other materials, except as permitted by U.S. copyright law. Such materials may be used for educational purposes only, in a location not accessible by the general public.

Lab Workbook

Residential Wiring Concepts and Applications: Activity 6-2

Name:
Date:
Class:

Chapter 6: Electrical Test Equipment

Activity 6-2

Measuring with a Digital Multimeter

Outcomes

After completing this lab activity, you will be able to:

- Measure voltage, resistance, and continuity with a digital multimeter.

Text Reference

Chapter 6, *Electrical Test Equipment*

Materials/Equipment

The following tools and equipment are needed to perform this activity:

- Digital multimeter (DMM)
- Light bulb
- Panelboard
- Piece of insulated conductor
- Receptacle, installed
- Single-pole switch

Introduction

Electricians use electrical test equipment to measure electrical characteristics in circuits and devices. These measurements can be used to ensure a circuit is safe to work on, to troubleshoot circuit and device problems, and to check that a circuit is functioning correctly.

Safety Review

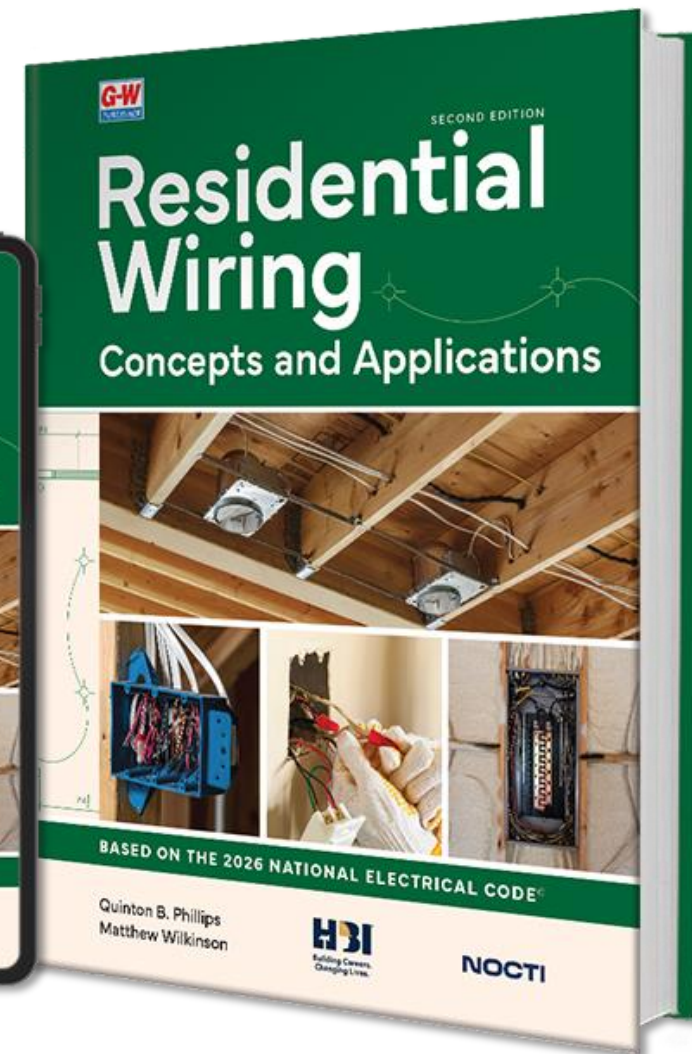
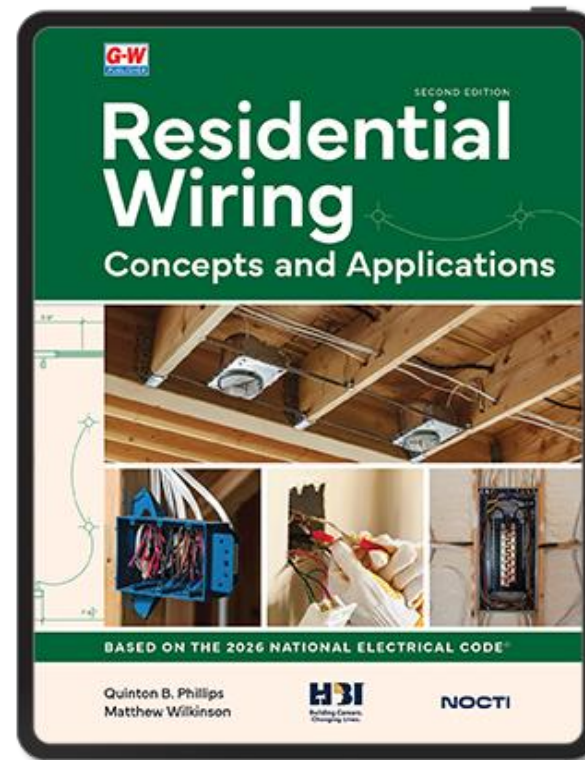
Follow all safety procedures specified by your instructor and in any appropriate manufacturer's information. The following is an additional safety-related item to keep in mind:

- Be careful when performing electrical tests on live circuits. Be deliberate in your actions and avoid making unnecessary contact with exposed terminals and conductors.

1

Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. You may not reproduce, create derivative works from, utilize any AI technology with respect to, or allow unauthorized access to, any other materials, except as permitted by U.S. copyright law. Such materials may be used for your own educational purposes only, in a location not accessible by the general public.

Integrate G-W Digital Student Resources



©2027, 2nd edition, 544 pp.
by Quinton Phillips and Matthew Wilkinson



PART 1 Basic Knowledge and Skills

SECTION 1 Introduction to Residential Wiring

- 1 Getting Started in the Industry
- 2 Electrical Fundamentals
- 3 Safety in Residential Wiring

SECTION 2 Tools and Hardware Used in House Wiring

- 4 Hand Tools
- 5 Power Tools
- 6 Electrical Test Equipment
- 7 Fasteners and Anchors

SECTION 3 Materials Used in House Wiring

- 8 Electrical Boxes
- 9 Electrical Conductors and Connectors
- 10 Electrical Conduit
- 11 Electrical Devices
- 12 Panelboards, Overcurrent Protective Devices, and Disconnects
- 13 Lamps and Lighting

SECTION 4 The National Electrical Code and Construction Basics

- 14 The NEC: Purpose, Scope, and Navigation
- 15 Print Reading and Estimating
- 16 Residential Framing

PART 2 House Wiring

SECTION 5 House Wiring and the NEC

- 17 Branch Circuit and Receptacle Requirements
- 18 Ampacity Adjustments and Conductor Sizing
- 19 Service Calculations

SECTION 6 Rough-In

- 20 Temporary Power
- 21 Outlet Box Installation
- 22 Switch Wiring Applications
- 23 Conductor Routing and Installation

SECTION 7 Service Installation

- 24 Service Equipment
- 25 Service Installation

SECTION 8 Finish and Trim

- 26 Device and Appliance Finish and Trim
- 27 Luminaire Finish and Trim
- 28 Distribution Panel Finish and Trim
- 29 Branch Circuit Testing and Troubleshooting

SECTION 9 Outdoor Circuits

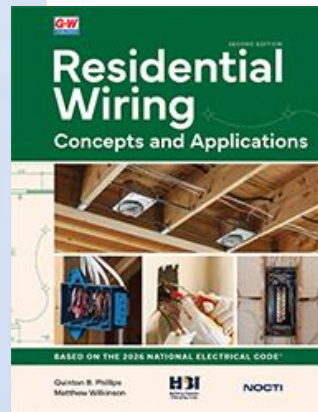
- 30 Outdoor Lights and Receptacles
- 31 Swimming Pools and Hot Tubs

SECTION 10 Special Wiring Applications

- 32 Voice, Data, and Video
- 33 Signaling Devices
- 34 Solar Photovoltaic Systems
- 35 Garage Wiring and Electric Vehicle Charging Power
- 36 Standby Power Systems

SECTION 11 Retrofitting, Service, and Repair

- 37 Troubleshooting Basics
- 38 Replacing and Adding Devices and Luminaires
- 39 Adding a Circuit
- 40 Service Upgrades



Student Textbook

CHAPTER 2 Electrical Fundamentals

Introduction

- 2.1 Electricity and Atomic Structure
- 2.2 Magnetism and Induction
- 2.3 Electrical Circuit Fundamentals
- 2.4 Electrical Properties
- 2.5 Electrical Systems
- 2.6 Power Generation
- 2.7 Power Transmission and Distribution Fundamentals

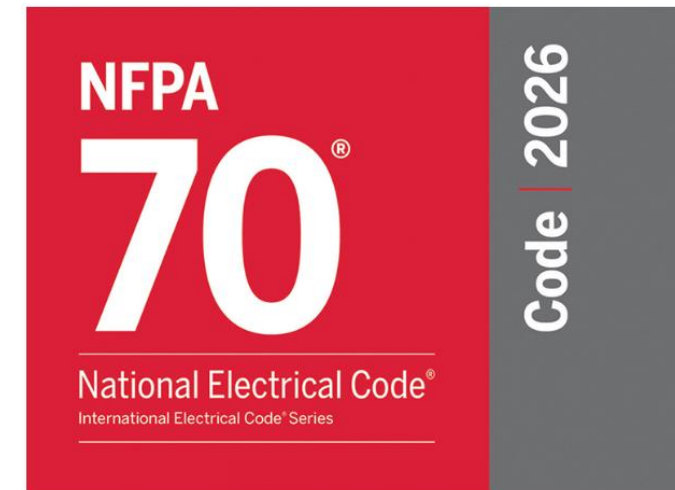
CHAPTER 33 Signaling Devices

Introduction

- 33.1 Life Safety Signaling Devices
- 33.2 Door and Security Signaling Devices
- 33.3 Remote Control Signaling Devices

CHAPTER 14

The NEC: Purpose, Scope, and Navigation



Reproduced with permission of NFPA from NFPA 70, National Electrical Code, 2026 edition. Copyright © 2025, National Fire Protection Association. For a full copy of the NFPA 70, please go to www.nfpa.org

CODE APPLICATION

Direct-Buried Conduit

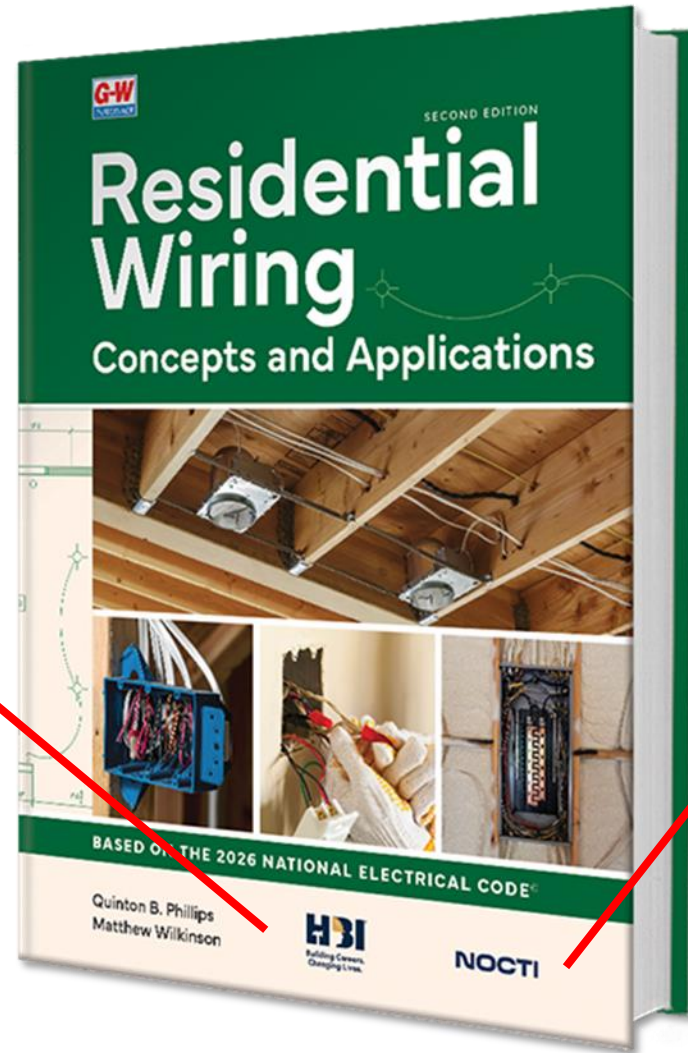
Scenario: An electrician needs to know what type of cable to install in a conduit that is to be directly buried underground.

Section 300.7(B): The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in these enclosures or raceways in underground installations shall comply with *Section 310.10(C)*.

Solution: *Section 300.7(B)* pertains to the underground installation of conductors. It classifies the inside of a direct-buried conduit to be a wet location, so all conductors or cables installed must be listed as suitable for use in wet locations. UF cable is listed for use in wet locations. NM cable is not listed as suitable for wet locations.

Application: Determine which of the following nonmetallic conduits would *not* be permitted to be used for direct burial: PVC, LFNC, and ENT.

What's New to the Edition



NOCTI

Credentialing Partners



CHAPTER 2 SPARKING DISCUSSION ⚡

What role does the residential electrician play in the generation, transmission, distribution, and utilization of electricity?

CHAPTER 2 LEARNING OUTCOMES

After completing this chapter, you will be able to:

- 2.1 Describe how atomic structure plays a role in a material's ability to conduct electricity.
- 2.2 Discuss the relationship between electricity, magnetism, and energy.
- 2.3 Describe how a simple electrical circuit operates under normal conditions.
- 2.4 Determine the value of unknown electrical quantities using Ohm's law and Watt's law.
- 2.5 Contrast single-phase and three-phase electrical systems.
- 2.6 Summarize electrical power generation sources and the generation process.
- 2.7 Explain the role of transmission and distribution in the electrical power system.

CHAPTER 2 TECHNICAL TERMS ↗

- alternating current (ac)
- amp
- combination circuit
- conductor
- current
- demand profile
- direct current (dc)
- distribution transformer
- electrical fault
- equipment grounding conductor
- grounded conductor
- ground fault
- insulator
- load
- neutral conductor
- nominal
- ohms
- Ohm's law
- overcurrent
- parallel circuit
- peak hours
- power
- power distribution

Chapter 2 Introduction

This chapter provides an overview of electrical fundamentals, intending to build this knowledge through each subsequent chapter. Students will ultimately gain the necessary skills to find success as a residential electrician, but every expert electrician begins with learning the foundations of electrical theory. Although electrical theory can be very complex, the basics of electrical circuits are approachable and comprehensible.

Chapter-Opening Materials



CODE APPLICATION

Wiring Device Terminations

Scenario: When wiring a duplex receptacle wiring device, what is the maximum size conductor that can be used with push-in or backstab terminations?

Section 406.10: This section outlines the requirements for screwless terminals of the push-in-type on wiring devices, such as duplex receptacles.

Solution: When navigating the code, identify key words associated with the place, wiring method or material, equipment, or condition that is the most specific. In this scenario, multiple key words are possible, including *duplex receptacle*, *wiring device*, *conductor*, and *terminations*. Since the question is asking about a specific type of equipment, *wiring devices*, use that as a key word. *Article 406, Wiring Devices*, comes to the forefront.

The next step is to identify the relevant part in *Article 406*. The scenario is asking about a general installation requirement, so this information should be contained within *Part I, General*. Review the numbered sections for a title that may have something to do with duplex receptacle use or installation, which leads to *Section 406.10 Wiring Device Terminations*.

Evaluate the subdivisions to find something that may apply to the scenario. *Section 406.10(3)* provides the solution that duplex receptacles using screwless terminals of the push-in type shall be installed on not greater than 15-amp circuits and connected with 14 AWG solid copper.

Application: Determine the minimum distance required between a non-type IC recessed luminaire and thermal insulation in the ceiling of a dwelling unit.

PROCEDURE

Troubleshooting a Circuit Breaker

Complete the following steps to troubleshoot a circuit breaker after it trips or shorts when it becomes energized.

1. Ensure the power is off.
2. Set your electrical meter to test resistance. Go to any receptacle on the main panel and test the resistance between the ungrounded and grounded (neutral) conductor or the grounding electrode conductor.
3. If you read zero resistance (measured in ohms), this indicates a short circuit or ground fault has occurred.
4. Test all light switches in the OFF position, or all the light bulbs, ballasts, or LED drivers while disconnected. Every light source, ballast, or driver has internal resistance that exists under normal conditions, but this resistance is not low enough to allow enough current to trip the circuit breaker.
5. Work now to determine the location of the short circuit. Examine every switch and receptacle until the problem is found. Note: if a problem is not detected, the issue may be buried in the wall.

PRO TIP

Metric Prefixes

Electrical quantities can be very large and very small. Metric prefixes are used to simplify the expression of a quantity. Rather than stating the current of a circuit as 0.003 A, the value can be expressed using the metric prefix *milli*. Milli is a factor of 10^{-3} and symbolized as *m*. The metric prefix symbol is added in front of the electrical quantity in the expression. In this case, the current would be stated 3 mA. When using any of the Ohm's law or Watt's law formulas, all values must be converted back to the base unit before the calculation. Refer to **Figure 2-11** for common metric prefixes used in the electrical industry.

Larger Units	Giga	G	10^9	1,000,000,000	Smaller Units
	Mega	M	10^6	1,000,000	
	Kilo	k	10^3	1,000	
	Base Unit		10^0	1	
	Milli	m	10^{-3}	0.001	
	Pico	p	10^{-12}	0.000 000 000 001	

Goodheart-Willcox Publisher

Figure 2-11. When transitioning between metric designators, if the prefix unit is smaller the decimal place should move to the right, making the number larger. If the prefix unit is larger, the decimal place should move to the left, making the number smaller.


Description

SAFETY NOTE

Electrical Return Path

In an electrical circuit, the electrons are seeking a pathway to return to the source. A common misconception is that electricity is looking for any path to the ground and if something is grounded or connected to the earth, then it is safe. This is not the case. Electrons may use the ground as a pathway back to the source, but electricity does *not* flow to the ground.

Special Features




CHAPTER 2 REVIEW

Summary

- A conductor is an element with a small number of valence electrons. An insulator is an element with a large number of valence electrons. (2.1)
- Electrical current in a conductor produces a magnetic field. A magnetic field can induce voltage and current in an adjacent conductor. (2.2)
- An open circuit is one where no current can flow. A closed circuit is one where the current can flow. The flow of electricity can be manipulated by switches and overcurrent devices such as fuses and circuit breakers. (2.3)
- A short circuit is a fault condition where the load has been unintentionally bypassed, resulting in dangerously high current flow. A ground fault is an accidental contact between an energized conductor and a grounded conductor or grounded equipment frame. (2.3)

Know and Understand

Answer the following end-of-chapter questions using the information provided in this chapter.

1. The number of electrons in the ____ shell of an element's atom plays a role in the material's ability to conduct electricity. (2.1)
 - A. valence
 - B. inner
 - C. Bohr
 - D. emitter
 2. *True or False?* The magnetic fields of a conductor wrapped into a coil are additive and produce a larger magnetic field. (2.2)
 3. The three components of an electrical system are the ____, ____, and _____. (2.3)
 - A. power source, grounding conductor, grounded conductor
 - B. light bulb, switch, fuse
 - C. conductors, fuse, circuit breakers
 - D. power source, conductors, load
 4. *True or False?* Electrical current can flow in a closed circuit. (2.3)
 5. Current that flows outside the normal pathway, essentially bypassing the load, is known as a(n) _____. (2.3)
 - A. ground fault
 - B. overcurrent fault
 - C. short circuit
 - D. overload fault
- 

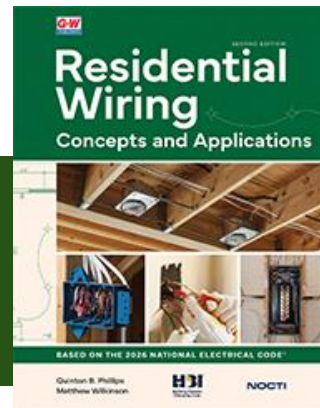
Apply and Analyze

1. A 240-volt electrical appliance produces a current flow of 50 amps. What is the resistance of the appliance? (2.4)
2. How much power is used by a 120-volt electrical load that produces 15 amps of current flow? (2.4)
3. An electrical circuit produces 5000 watts of power and has 11 ohms of resistance. What is the applied voltage of this circuit? (2.4)

Critical Thinking




1. What function do fuses and circuit breakers perform in a residential electrical circuit? (2.3)
2. How can an electrician use Ohm's law or Watt's law to properly size conductors for an electrical circuit? (2.4)
3. What methods do utilities use to match power generation to fluctuating usage throughout the day? (2.7)

End-of-Chapter Content





Chapter 6 Electrical Test Equipment ▼

-  Activity 6-1 Chapter Review
-  Activity 6-2 Measuring with a Digital Multimeter
-  Activity 6-3 Using Electrical Test Equipment

Residential Wiring Concepts and Applications: Activity 6-1

Name:
Date:
Class:

Chapter 6: Electrical Test Equipment

Activity 6-1

Chapter Review Questions

Complete the following questions after carefully reading the corresponding chapter.

1. *True or False?* A solenoid voltage tester does not need to be connected to exposed energized components to get a reading. (6.1)

Answer:

2. Ghost voltages are a drawback of _____. (6.1)

- A. analog voltmeters
- B. solenoid voltage testers
- C. digital voltmeters
- D. non-contact voltage testers

Answer:

3. All measurements on a multimeter are made using test _____. (6.2)

Answer:

4. Which of the following measurements should *not* be taken on an energized circuit? (6.2)

- A. Continuity
- B. Current
- C. Voltage
- D. You should never take measurements on an energized circuit.

Answer:

5. *True or False?* The clamp meter is a safer alternative to the in-line ammeter. (6.3)

Answer:

1

Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. You may not reproduce, create derivative works from, utilize any AI technology with respect to, or allow unauthorized access to, any G-W course or other materials, except as permitted by U.S. copyright law. Such materials may be used for your own educational purposes only, in a location not accessible by the general public.

Residential Wiring Concepts and Applications: Activity 6-2

Name:
Date:
Class:

Chapter 6: Electrical Test Equipment

Activity 6-2

Measuring with a Digital Multimeter

Outcomes

After completing this lab activity, you will be able to:

- Measure voltage, resistance, and continuity with a digital multimeter.

Text Reference

Chapter 6, *Electrical Test Equipment*

Materials/Equipment

The following tools and equipment are needed to perform this activity:

- Digital multimeter (DMM)
- Light bulb
- Panelboard
- Piece of insulated conductor
- Receptacle, installed
- Single-pole switch

Introduction

Electricians use electrical test equipment to measure electrical characteristics in circuits and devices. These measurements can be used to ensure a circuit is safe to work on, to troubleshoot circuit and device problems, and to check that a circuit is functioning correctly.

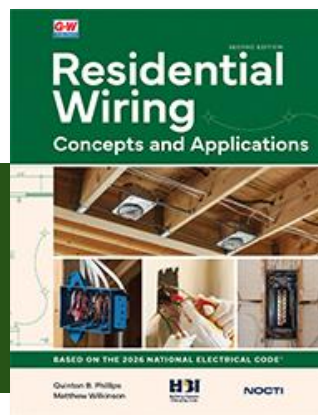
Safety Review

Follow all safety procedures specified by your instructor and in any appropriate manufacturer's information. The following is an additional safety-related item to keep in mind:

- Be careful when performing electrical tests on live circuits. Be deliberate in your actions and avoid making unnecessary contact with exposed terminals and conductors.

1

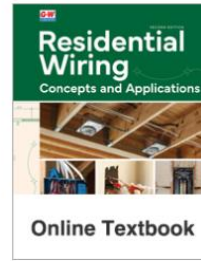
Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. You may not reproduce, create derivative works from, utilize any AI technology with respect to, or allow unauthorized access to, any G-W course or other materials, except as permitted by U.S. copyright law. Such materials may be used for your own educational purposes only, in a location not accessible by the general public.



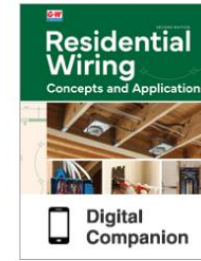
Lab Workbook



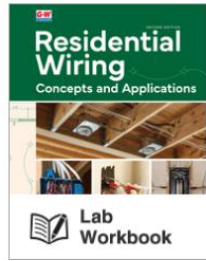
Residential Wiring Concepts & Applications 2e, eBook



Residential Wiring Concepts & Applications 2e, Online Textbook



Residential Wiring Concepts & Applications 2e, Digital Companion



Residential Wiring Concepts & Applications 2e, Lab Workbook



Residential Wiring Concepts & Applications 2e, Animations



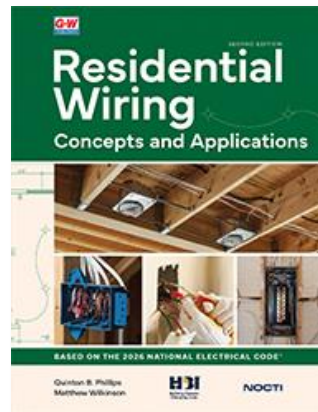
Residential Wiring Concepts and Applications, Virtual Toolbox



Residential Wiring Concepts & Applications 2e, Instructor Resources



Residential Wiring Concepts & Applications 2e, Image Library



Residential Wiring Concepts & Applications 2e, G-W Assessment



Electrical Wiring Video Library

Digital Assets



Circuit Breaker

200 Amp 2 Pole
 120/240 V ~ 60Hz 40°C
 Cat. CSH2200N
 Style 7803C07G43

Interrupting Capacity
 RMS Sym. Amps
 Volts Amps
 120/240 ~ 35k

Terminal Wire	Wire Size	Torque Lb. in.
CU/AL	2-300	250

CODE ARRANGEMENT

Chapter 1: General Chapter 2: Wiring and Protection Chapter 3: Wiring Methods and Materials Chapter 4: Equipment for General Use	} Applies generally to all electrical installations
Chapter 5: Specific Occupancies and Locations Chapter 6: Specific Equipment Chapter 7: Specific Conditions and Systems	} Supplements or modifies Chapters 1 through 7
Chapter 8: Communications Systems	} Chapter 8 is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8

NEC Revisions and Extracted Text

Formatting	Meaning
SHADED TEXT	Shading behind text is used to indicate revisions from the previous issue of the code. For example, see Section 110.3 where additional considerations for equipment examination have been added to the NEC.
<i>N</i>	A bold, italic <i>N</i> with shading is used to indicate new material. For example, see Section 110.3 where additional information about torquing requirements for high-voltage electrical connections has been added.
•	A bullet is used to indicate that one or more paragraphs have been deleted. For example, see Section 110.17 where all requirements for preventative maintenance of equipment included in the 2023 NEC have been deleted in the 2026 NEC.
[EXTRACTED TEXT]	Brackets are used to denote text extracted from another document that appears in the code. For example, see Section 517.35(A) which is extracted from Health Care Facilities Code, and Section 6.7.5.1.4.2(A).

as referenced
 optional only; not mandatory



Goodheart-Willcox Publisher

Figure 14-4. NEC revisions and extracted text.

Residential Wiring Concepts & Applications 2e © by Goodheart-Willcox Co., Inc. Grigovan/Shutterstock.com

Images and Illustrations

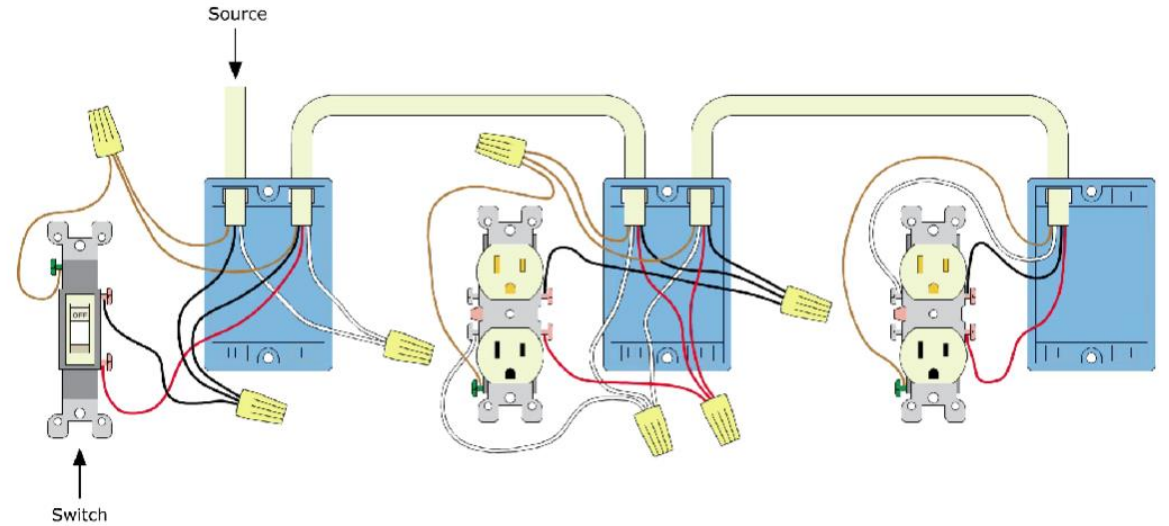


Electrical Testing Tools E-Flash Cards



Klein Tools

Split Receptacle with Switch Circuit



Be the electron and follow the paths of current through the circuit.

Virtual Toolbox and Animations