

# Modern Commercial Wiring



## Modern Commercial Wiring: Lesson Plan

Instructor:

Date:

Course:

Unit:

### Chapter 1: Electrical Fundamentals Review

#### Chapter Objectives

- 1.1 Identify basic units for electrical voltage, current, resistance, energy, and power.
  - 1.1 Basic Electrical Circuit Units
- 1.2 Define series, parallel, and complex circuits and calculate voltage, current, and resistance.
  - 1.2 Basic Circuits
- 1.3 Summarize the elements of alternating currents.
  - 1.3 Alternating Current
- 1.4 Distinguish between nominal voltage and rated voltage.
  - 1.4 Utilization Voltages

#### Instructional Resources

- Textbook/eBook: Chapter 1
- Instructor Resources: Chapter 1 Instructor's Presentation for PowerPoint
- Instructor Resources: Chapter 1 Answer Key
- Other instructional resource:

#### Resources for Practice and Application

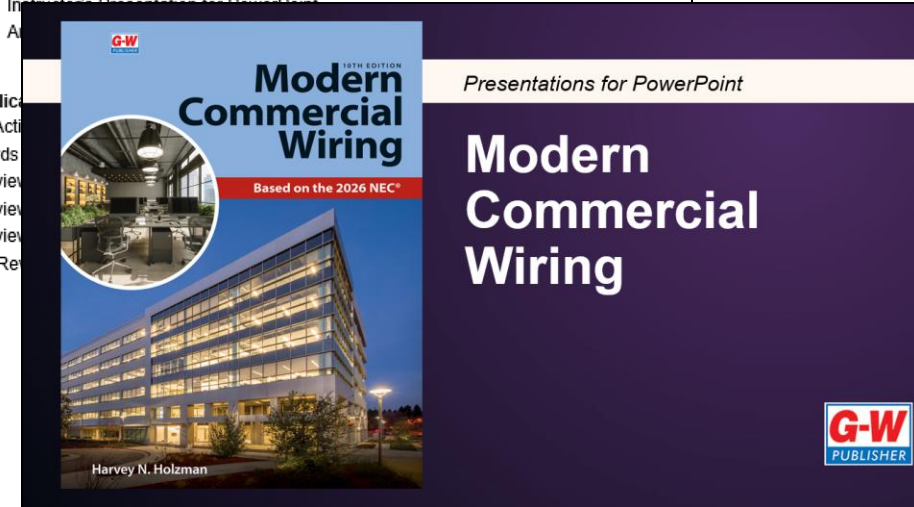
- Digital Companion: Interactive Activities
- Digital Companion: E-Flash Cards
- Textbook/eBook: Chapter 1 Review
- Textbook/eBook: Chapter 1 Review
- Textbook/eBook: Chapter 1 Review
- Workbook: Chapter 1–Chapter Review
- Other resource(s)

#### Assessment

- Assessment Suite
  - Chapter 1 Pretest
  - Chapter 1 Posttest
  - Chapter 1 Exam
- Other assessment:

#### Additional Notes

- Other notes:



**Lesson Plans, PowerPoint Presentations, and Answer Keys**



# Print • Digital • Bundle Options Available



Blackboard<sup>®</sup> D2L  
**BRIGHTSPACE**  canvas

 moodle  schoolology<sup>®</sup>  Additional  
LTI-Compliant  
Platforms

**Clever**   
ClassLink

  
1EDTECH  
CERTIFIED

  
Google Classroom

## LMS and CMS Integration Easy Navigation

1: E-Flash Cards

Term (1 of 47)

Select to flip

alternating current (ac)

## E-Flash Cards & Vocabulary Practice

Definition (1 of 47)

A form of electrical current that cycles continuously so it flows forward and reverse in one cycle, repeating this as long as continuity remains.

Previous Remove Next

Select a point value. Choose the term that matches the definition. Score: 800

<input checked="" type="checkbox"/>	100	100	<input checked="" type="checkbox"/>	100
<input type="checkbox"/>	200	<input checked="" type="checkbox"/> -200-	<input type="checkbox"/>	200
<input type="checkbox"/>	300	<input checked="" type="checkbox"/> -300-	<input checked="" type="checkbox"/>	300
<input checked="" type="checkbox"/>	400	400	<input checked="" type="checkbox"/>	400

**Definition:** In an inductive ac circuit, electric current that reaches its peak value after voltage has reached its peak value.

~~armature~~

inductive reactance ( $X_L$ )

lagging current

impedance ( $Z$ )

Check Answer

## Interactive Activities

Modern Commercial Wiring; Chapter 1 Review

Name: \_\_\_\_\_  
Date: \_\_\_\_\_  
Class: \_\_\_\_\_

**Chapter 1: Electrical Fundamentals Review**

**Know and Understand**

Answer the following questions using the information provided in the chapter.

- The rate of flow of electricity is known as \_\_\_\_\_. (1.1)
  - current
  - voltage
  - resistance
  - All are correct.
 Answer: \_\_\_\_\_

For Questions 2–5, match the units to the electrical characteristic.

- Amperes
- Ohms
- Volts
- Watts

- Units of current. (1.1)  
Answer: \_\_\_\_\_
- Units of voltage. (1.1)  
Answer: \_\_\_\_\_
- Units of resistance. (1.1)  
Answer: \_\_\_\_\_
- Units of power. (1.1)  
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.

## Review Questions

Modern Commercial Wiring; Chapter 1 Review

- True or False? A circuit that has three separate pathways for current is considered a series circuit. (1.2)  
Answer: \_\_\_\_\_
- True or False? In a parallel circuit, the voltage is equal across all branches of the circuit. (1.2)  
Answer: \_\_\_\_\_

Use the following circuit for Questions 8–12.

8. What is the voltage at  $R_1$ ? (1.2)

- 13.3 V
- 24.8 V
- 58.2 V
- 65.25 V

Answer: \_\_\_\_\_

9. What is the voltage at  $R_2$ ? (1.2)

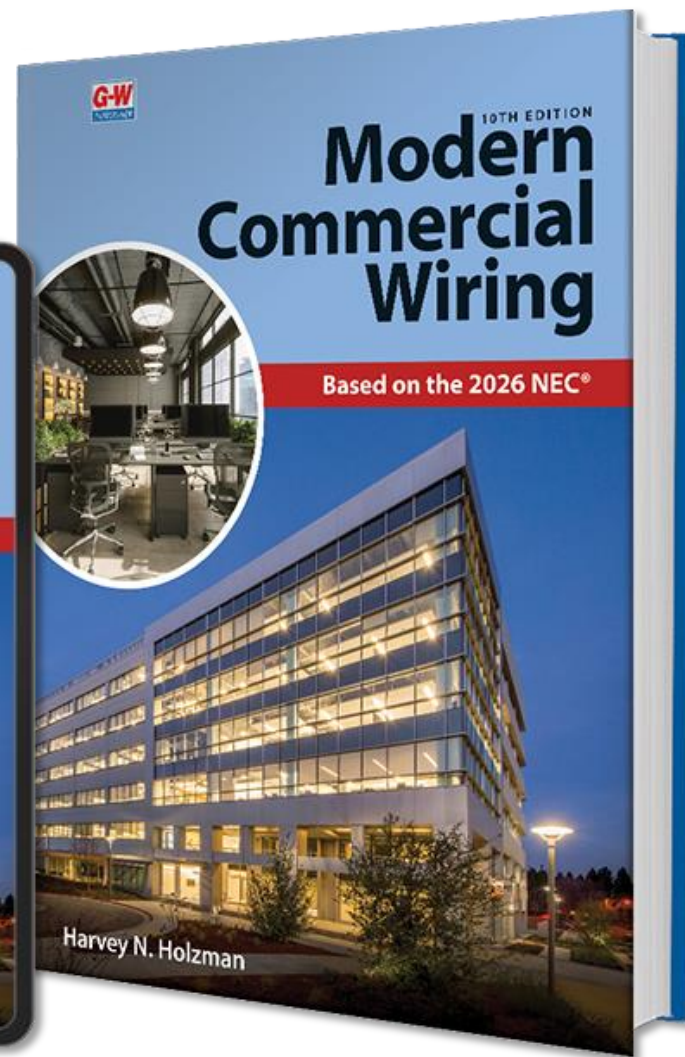
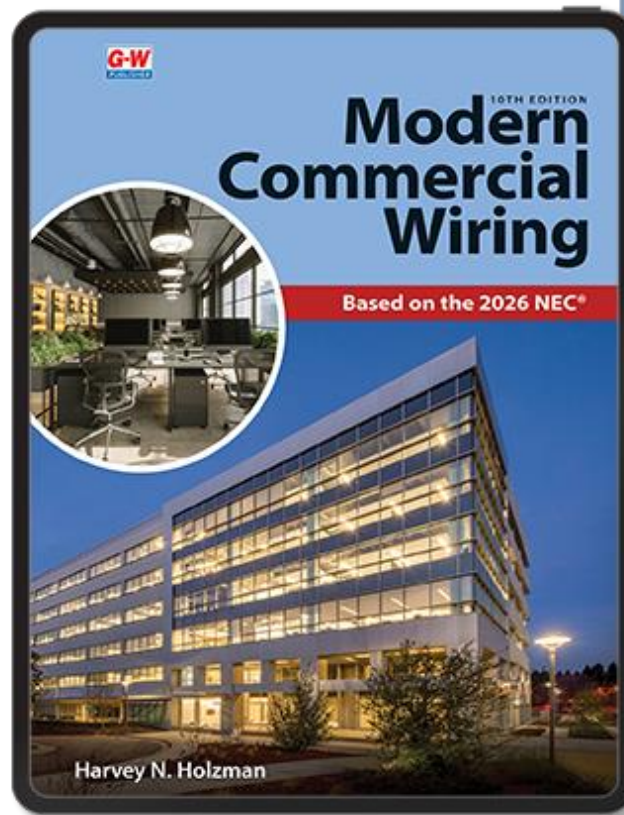
- 12.8 V
- 33.25 V
- 48.65 V
- 82.5 V

Answer: \_\_\_\_\_

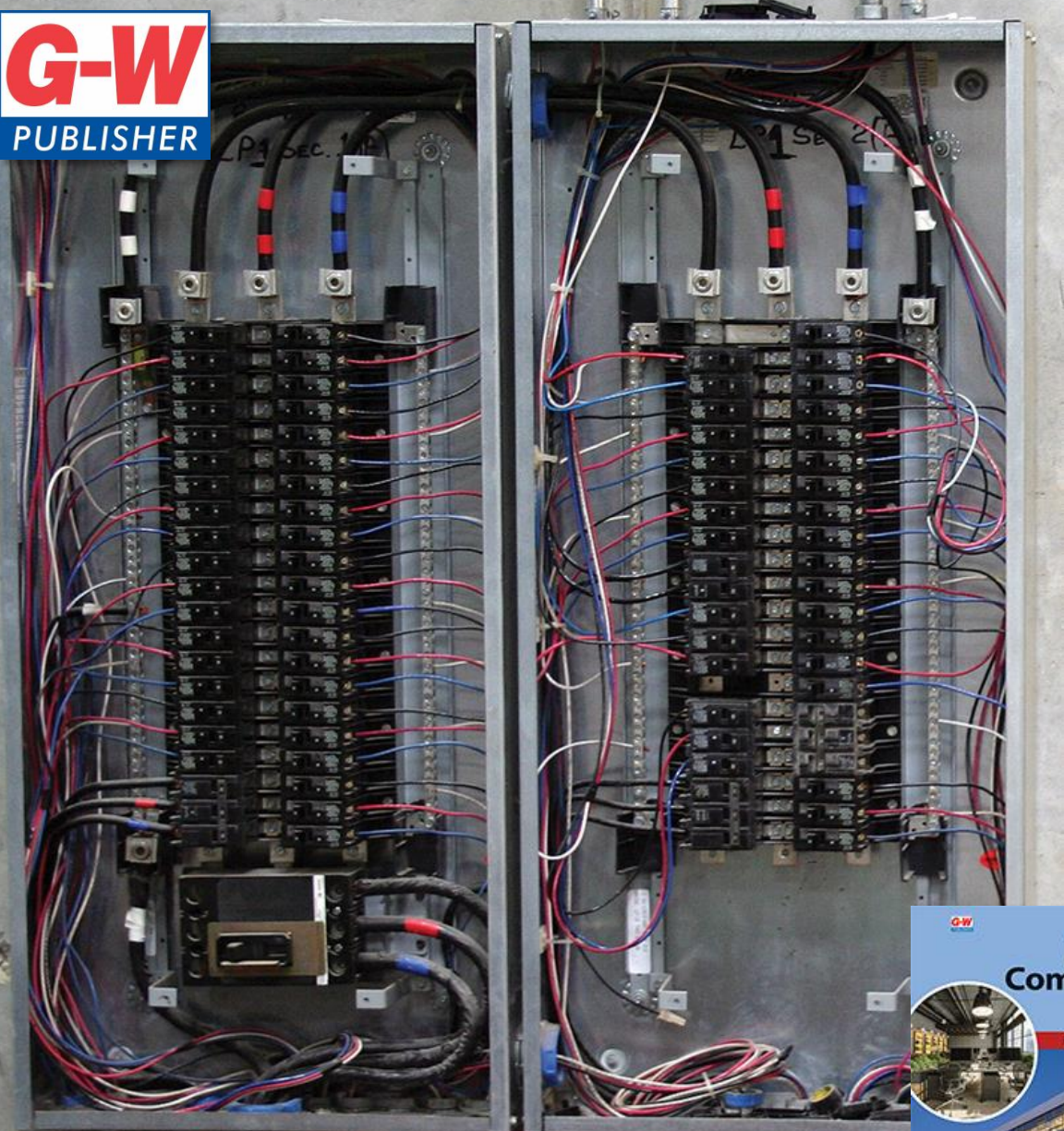
2 Copyright © Goodheart-Willcox Co., Inc. All Rights Reserved. You may not reproduce, create derivative works from, utilize any AI technology with respect to, or allow unauthorized access to, any G-W course or other materials, except as permitted by U.S. copyright law. Such materials may be used for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

# Integrate G-W Digital Student Resources

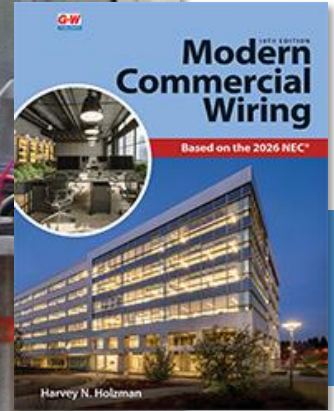
**G-W**  
PUBLISHER



©2027, 10th edition, 320 pp.  
by Harvey N. Holzman



1	<b>Electrical Fundamentals Review</b>
2	<b>Safety</b>
3	<b>Tools</b>
4	<b>Electrical Prints, Specifications, and Codes</b>
5	<b>Wiring Methods</b>
6	<b>Conductors</b>
7	<b>Boxes and Conduit Bodies</b>
8	<b>Overcurrent Protection</b>
9	<b>Service and Distribution</b>
10	<b>Transformers</b>
11	<b>Grounding</b>
12	<b>Branch Circuits and Feeders</b>
13	<b>Motors</b>
14	<b>Motor Controls</b>
15	<b>Emergency Power</b>
16	<b>Hazardous Locations</b>
17	<b>Pools and Fountains</b>
18	<b>Maintenance and Troubleshooting</b>



# Student Textbook

## Know the Code

A copy of the NEC 2026 is required to answer these questions. Questions 1–5 refer to Part VI (Motor Control Circuits) of Article 430.

1. Under what circumstances should motor control circuit conductors be contained in raceway?
2. The overcurrent protection requirements in Section 430.72 are applicable for tapped control circuits. If the circuit is separately connected to a power panel, which section must be referenced to determine the required overcurrent protection?
3. What are the basic overcurrent protection requirements for control circuits separately connected to a power panel?
4. Section 430.7 requires that certain markings be present on motors and multi-motor equipment. What marking is required for a single-speed motor?
5. If two devices are used as a means of disconnecting, what specifically do each of the devices disconnect and how must the devices be located?

Questions 6–10 refer to Part VII (Motor Controllers) of Article 430.

6. What types of machines must be provided with speed-limiting devices?  
a. In general, should the horsepower rating of a motor controller be higher or lower than the motor's horsepower rating?  
b. In what three positions must an autotransformer be provided when starting under a weakened field permit speed motor?  
c. Under what condition must the motor control conductors be bundled?

Code | 2026

NFPA

70<sup>®</sup>

National Electrical Code<sup>®</sup>  
International Electrical Code Series



## Chapter 1 Learning Outcomes

Information in this chapter will enable you to:

- 1.1 Identify the basic units for electrical voltage, current, resistance, energy, and power.
- 1.2 Define series, parallel, and complex circuits and calculate voltage, current, and resistance.
- 1.3 Summarize the elements of alternating currents.
- 1.4 Distinguish between nominal voltage and rated voltage.

## 1.1 Basic Electrical Circuit Units

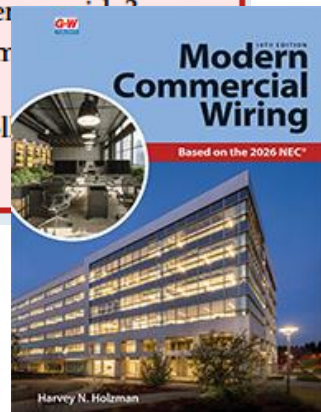
### Chapter 1 Summary

- The basic units of electricity are current ( $I$ ), voltage ( $E$ ), and resistance ( $R$ ). (1.1)
- Work is the process by which an electrical circuit transforms energy from one type to another. Power ( $P$ ) is the rate at which this work is done. (1.1)

### Chapter 1 Know and Understand

Answer the following questions using the information provided in this chapter.

1. The rate of flow of electricity is known as \_\_\_\_\_. (1.1)



## What's New to the Edition



## CHAPTER 2

### Safety

#### Chapter 2 Outline

- 2.1 Cause of Accidents
  - Electrical Hazards
  - Hazardous Environments
- 2.2 Accident Prevention
  - Basic Safety Rules
  - Safety Equipment
  - Working on Energized Equipment
- 2.3 Helping an Injured Worker
- 2.4 First Aid Preparation

#### Chapter 2 Learning Outcomes

*Information in this chapter will enable you to:*

- 2.1 Cite examples of hazardous situations and hazards associated with electrical work.
- 2.2 Explain basic safety rules and safety equipment.
- 2.3 Employ basic procedures to aid an injured worker.
- 2.4 Prepare first aid for various injuries or accidents.

#### Chapter 2 Technical Terms

- confined space
- current path
- fibrillation
- lockout/tagout procedures

## Chapter-Opening Materials



**NOTE**

In formulas, voltage is represented by either  $E$  or  $V$ .  $E$  will be used in this text.



**CAUTION**

In a four-wire delta system, the phase that is *not* connected to the tapped winding is called the *high leg*. The voltage difference between the high leg and the neutral is greater than the difference between the other phases and the neutral. The high leg conductor must be identified with orange marking to prevent an electrician from mistaking it for one of the other phase conductors.



**SAFETY NOTE**

The most important rule for preventing electrical accidents is to disconnect the circuit or equipment before doing work on it.



**CODE ALERT**

**The Purpose of the NEC**

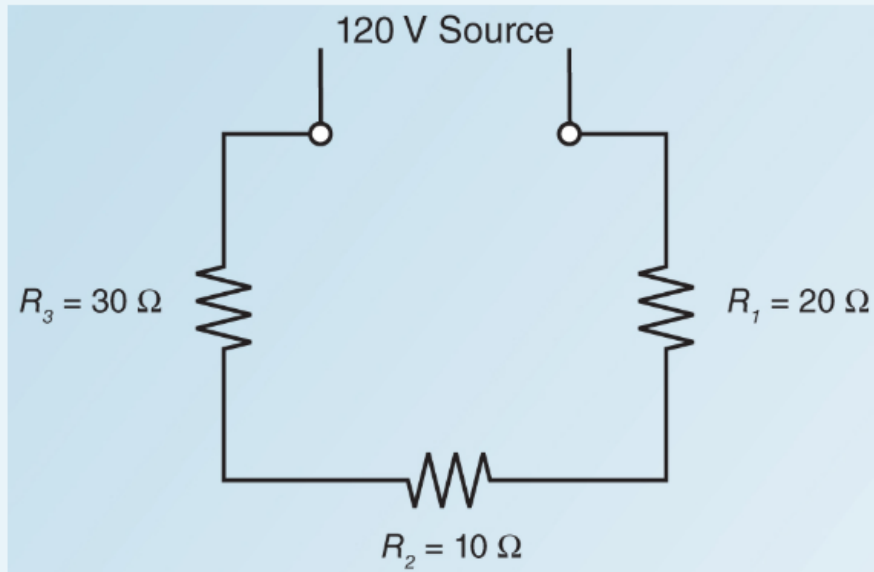
The *NEC* is not intended as a design specification nor an instruction manual for untrained persons.



# Special Features

**SAMPLE PROBLEM 1-1**

**Problem:** Using the following figure, calculate the current flowing through the circuit and the voltage at each resistor.



**Formulas:**

$$I_T = \frac{E_T}{R_T}$$
$$R_T = R_1 + R_2 + R_3$$
$$I_T = I_1 = I_2 = I_3$$
$$E_N = I_N R_N = I_T R_N$$

**Solution:** The current can be calculated using the formula:

**SAMPLE PROBLEM 12-12**

**Problem:** A small retail store is being constructed. Its power supply is single-phase, 120/240-volt. The store is 80' × 60' and has several loads:

- 50-kVA heating equipment
- 25-kVA air-conditioning unit
- 1/2-hp, 240-volt ventilating unit
- 60 duplex receptacles
- 40 linear feet of show-window lighting
- 1.2-kVA outdoor sign lighting

Copper THW conductors are used as feeders. What size should the current-carrying feeders be?

**Solution:** First, all the loads must be computed. The heating unit and air-conditioning unit will not be used at the same time, so only the larger load is needed. The 1/2-hp, 240-volt motor draws a current of 4.9 amps, as shown in *Table 430.248*.

# Sample Problems

## Chapter 14 Summary

- A motor controller regulates the power supply to a motor; they are often referred to as starters. (14.1)
- The two common classes of starters are manual and magnetic. (14.1)
- Power for magnetic starters is supplied by a motor control circuit. (14.2)

## Chapter 14 Know and Understand

Answer the following questions using the information provided in this chapter.

1. A general use ac snap switch can be used if the motor is rated at \_\_\_\_\_ hp or less. (14.1)
  - A. 2
  - B. 4
  - C. 6
  - D. 8
2. *True or False?* A motor control circuit often supplies the current used to run the motor. (14.2)
3. Most motor control circuits are rated for \_\_\_\_\_ volts or less. (14.2)
  - A. 90
  - B. 120
  - C. 460
  - D. 1000

lot devices can  
its or less. (14.3)  
control center

## Chapter 14 Apply and Analyze

1. How does a magnetic starter operate? (14.1)
2. A motor with a three-wire control circuit suddenly loses power. Explain why the motor will not automatically start when power is resumed. (14.3)

## Chapter 14 Critical Thinking

1. Explain the process of reversing dc motors. Give an example of a case where it would be necessary to run a motor in forward and reverse. (14.3)

## Know the Code

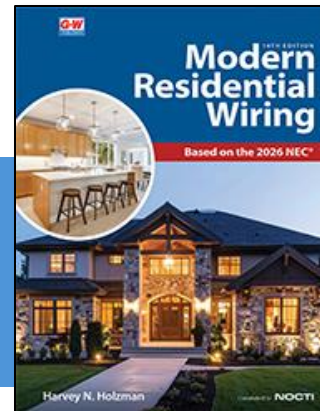
*A copy of the NEC 2026 is required to answer these questions. Questions 1–5 refer to Part VI (Motor Control Circuits) of Article 430.*

1. Under what circumstances should motor control circuit conductors be contained in raceway?
2. The overcurrent protection requirements in *Section 430.72* are applicable for tapped control circuits. If the circuit is separately connected to a power panel, which section must be referenced to determine the required overcurrent protection?
3. What are the basic overcurrent protection requirements for control circuits separately connected to a power panel?
4. *Section 430.7* requires that certain markings be present on motors and multi-motor equipment. What marking is required for a single-speed motor?
5. If two devices are used as a means of disconnecting, what specifically do each of the devices disconnect and how must the devices be located?

*Questions 6–10 refer to Part VII (Motor Controllers) of Article 430.*

6. What types of machines must be provided with speed-limiting devices?
7. In general, should the horsepower rating of a motor controller be higher or lower than the motor's horsepower rating?
8. What three positions must an autotransformer provide?
9. When is starting under a weakened field permitted for an adjustable-speed motor?
10. Under what condition must the motor controller open all ungrounded conductors?

# End-of-Chapter Content



Modern Commercial Wiring Workbook: Chapter 1

Name: \_\_\_\_\_  
Date: \_\_\_\_\_  
Class: \_\_\_\_\_

**Chapter 1: Electrical Fundamentals Review**

Complete the following questions and problems after carefully reading the corresponding material in the text.

List and label the three basic electrical units (1.1)

1. Identify the items indicated on the following diagram of an atom (1.1)

A. Answer: \_\_\_\_\_

B. Answer: \_\_\_\_\_

C. Answer: \_\_\_\_\_



Answers/Notes: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

2. \_\_\_\_\_ is the ability to flow in a wire. (1.1)  
Answer: \_\_\_\_\_

3. Which of the following is **not** a solid state? (1.1)

- A. Silver
- B. Aluminum
- C. Rubber
- D. Copper

Answer: \_\_\_\_\_

4. Which of the following is **not** an insulator? (1.1)

- A. Wood
- B. Copper
- C. Plastic
- D. Rubber

Answer: \_\_\_\_\_

5. The number of electrons that flow through a conductor in a given amount of time is measured in units called \_\_\_\_\_. (1.1)

Answer: \_\_\_\_\_

6. \_\_\_\_\_ force says electric forces (and) can be produced. Give an example of such. (1.1)

Answer: \_\_\_\_\_

7. Resistance is measured in unit's called \_\_\_\_\_. (1.1)

Answer: \_\_\_\_\_

8. \_\_\_\_\_ is the process by which energy is transferred from one type to another. (1.1)

Answer: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

9. Electric power is measured in \_\_\_\_\_ and is the product of voltage times current. (1.1)  
Answer: \_\_\_\_\_

**Answer the following series with the corresponding abbreviation.**

- A. **Z**
- B. **F**
- C. **P**
- D. **J**

10. Power (1.1)

Answer: \_\_\_\_\_

11. Voltage (1.1)

Answer: \_\_\_\_\_

12. Current (1.1)

Answer: \_\_\_\_\_

13. Resistance (1.1)

Answer: \_\_\_\_\_

14. The following figure shows the mechanical relationship of power, voltage, current, and resistance. Indicate the true quantity for each equation (1.1)

A. Answer: \_\_\_\_\_

B. Answer: \_\_\_\_\_

C. Answer: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

D. Answer: \_\_\_\_\_



Answers/Notes: \_\_\_\_\_

15. List the three basic components of all circuits (1.2)

16. Identify the type of circuit shown in the following illustration (1.2)



Answers/Notes: \_\_\_\_\_

17. The key to understanding and solving circuit problems is that \_\_\_\_\_ is applicable to any part of the circuit or the circuit as a whole. (1.2)

Answer: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

18. Calculate the current flowing through the circuit and the voltage on each resistor. (1.2)  
Circuit: correct: \_\_\_\_\_



Answers/Notes: \_\_\_\_\_

Voltage  $v_1$ : \_\_\_\_\_

Voltage  $v_2$ : \_\_\_\_\_

Voltage  $v_3$ : \_\_\_\_\_

19. Identify the following type of circuit. (1.2)

Answer: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1



Answer: \_\_\_\_\_

Answers/Notes: \_\_\_\_\_

20. Find the total circuit resistance of the following circuit (1.2)



Total circuit resistance

Answer: \_\_\_\_\_

Answers/Notes: \_\_\_\_\_

21. With respect to ohm's \_\_\_\_\_ (1.2)

Answer: \_\_\_\_\_

A. voltage rules apply to the entire portion of the circuit

B. voltage rules apply to the parallel part of the circuit

C. parallel rules apply to the parallel part of the circuit

D. Both A and C.

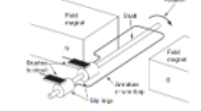
2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

22. What is electromagnetic induction? How is it accomplished? (1.3)  
Answer: \_\_\_\_\_

23. Explain what is occurring in the following diagram of an alternator. (1.3)



Answer: \_\_\_\_\_

Answers/Notes: \_\_\_\_\_

24. \_\_\_\_\_ voltage, such as 120 volts or 240 volts, refers to the effective voltage of a circuit. (1.3)

Answer: \_\_\_\_\_

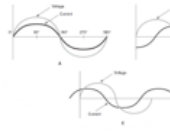
25. For each of the following diagrams, describe the relationship between the voltage and current. (1.3)

Answer: \_\_\_\_\_

2

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1



Answers/Notes: \_\_\_\_\_

A. Answer: \_\_\_\_\_

B. Answer: \_\_\_\_\_

C. Answer: \_\_\_\_\_

26. A coil with a solid core is one of the simplest types of \_\_\_\_\_ devices. (1.3)

Answer: \_\_\_\_\_

27. \_\_\_\_\_ is the condition whereby a circuit stores and then discharges (1.3)

Answer: \_\_\_\_\_

28. \_\_\_\_\_ is the total opposition to the flow of alternating current. (1.3)

Answer: \_\_\_\_\_

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

29. The \_\_\_\_\_ is the ratio of true power to the apparent power. (1.3)  
Answer: \_\_\_\_\_

30. \_\_\_\_\_ voltage is the potential voltage for equipment, particularly motors. (1.4)

Answer: \_\_\_\_\_

31. \_\_\_\_\_ **Drop or Pileup?** Commercial electrical systems are still in the category of their old name in voltage. High voltage is reserved for power and energy distribution systems. (1.4)

32. For each of the following diagrams, identify the basic voltage system derived from the voltage applied distribution illustrated. (1.4)



A. Answer: \_\_\_\_\_

Answers/Notes: \_\_\_\_\_



Answer: \_\_\_\_\_

Modern Commercial Wiring Workbook: Chapter 1

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.

Modern Commercial Wiring Workbook: Chapter 1

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

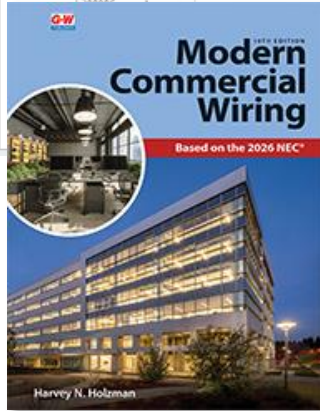
Answer: \_\_\_\_\_

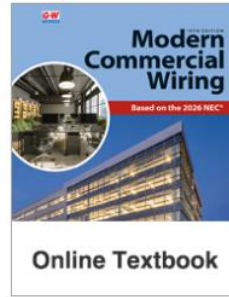
Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Answer: \_\_\_\_\_

Copyright © GoodandBeautiful.com, Inc. All rights reserved. This may not reproduce, modify, distribute, or otherwise be used in any form without the express written permission of GoodandBeautiful.com, Inc. This material may be used for your own educational purposes only; its creation not available by the general public.





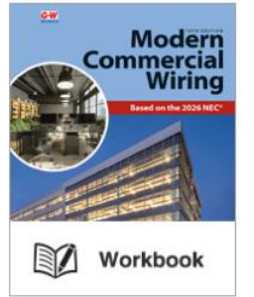
Modern Commercial Wiring 10e,  
Online Textbook



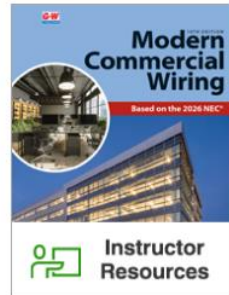
Modern Commercial Wiring 10e,  
eBook



Modern Commercial Wiring 10e,  
Digital Companion



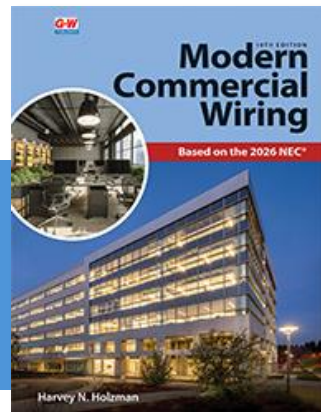
Modern Commercial Wiring 10e,  
Workbook



Modern Commercial Wiring 10e,  
Instructor Resources



Modern Commercial Wiring 10e,  
G-W Assessment



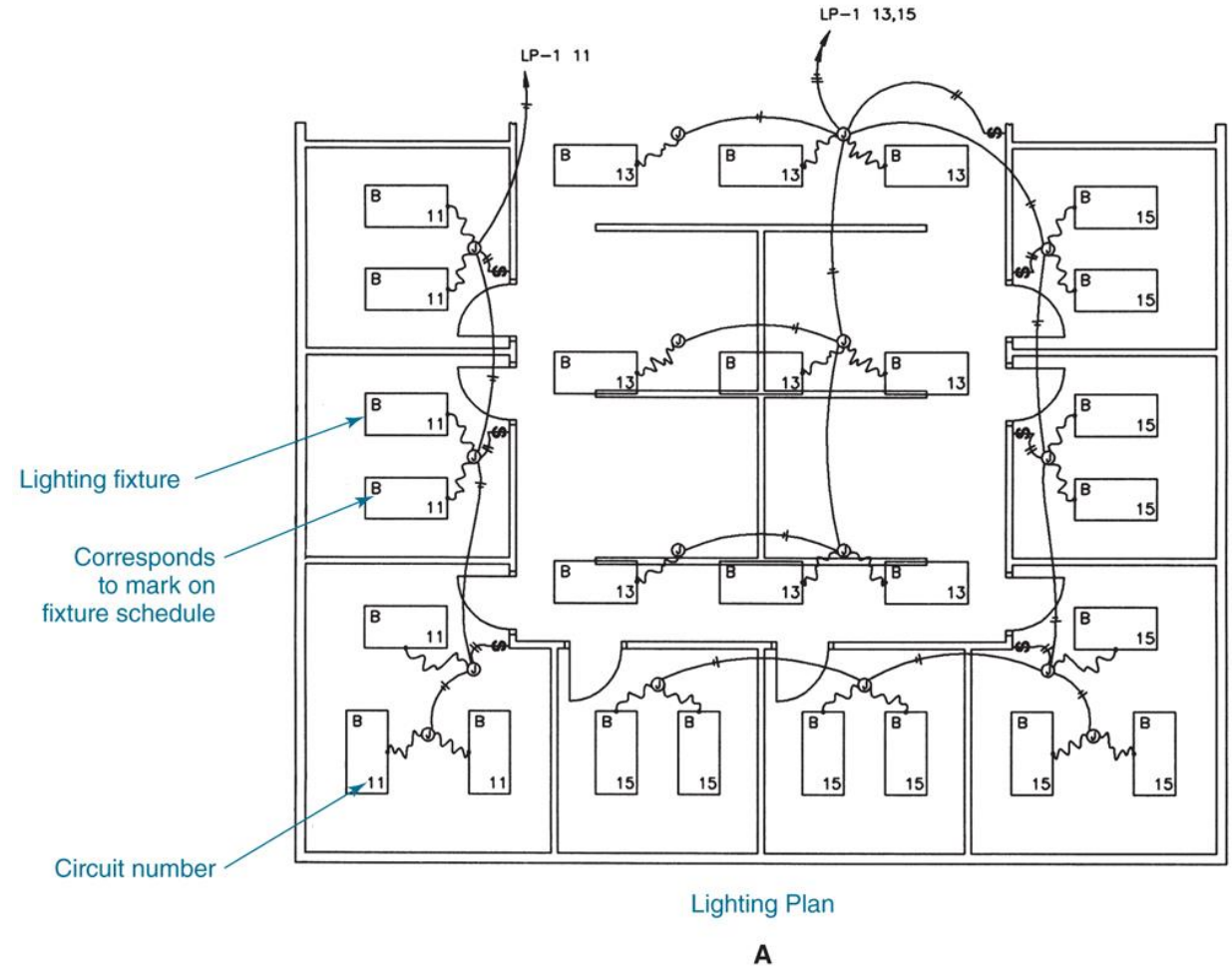
# Digital Assets



Courtesy of RIDGID®. RIDGID® is the registered trademark of RIDGID, Inc.  
**Figure 3-9.** Using a hydraulic crimper to attach a lug to the end of a large conductor.

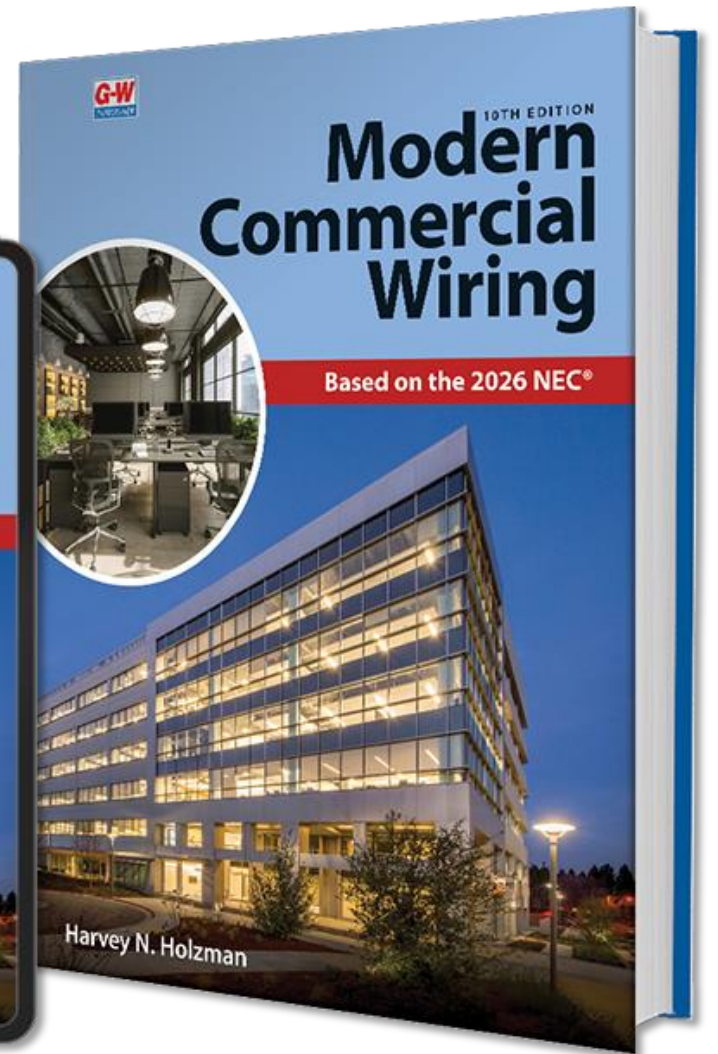
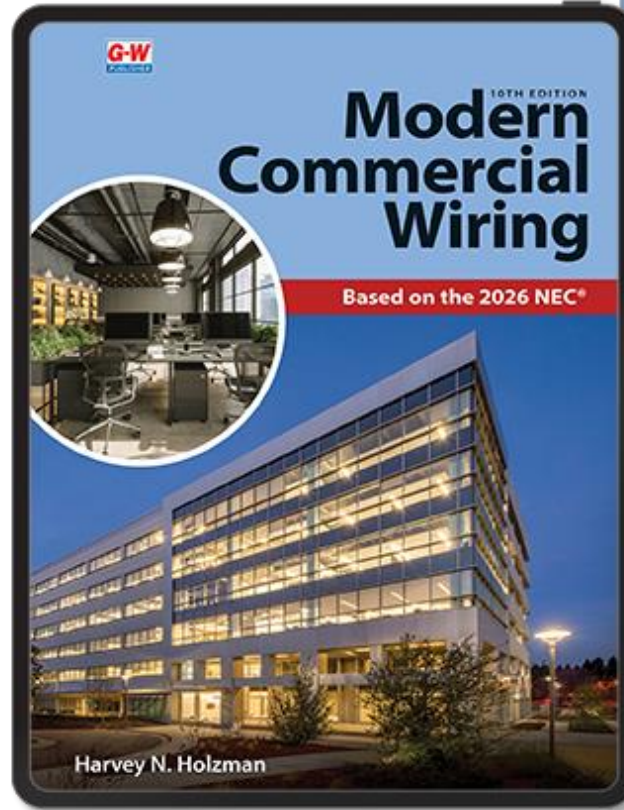


Milwaukee Tools  
**Figure 3-15.** Clamp-on meters are designed for high-energy systems and can test much higher levels of current and voltage than standard voltage testers and multimeters.



# Images and Illustrations

**G-W**  
PUBLISHER



Learn more at [www.g-w.com](http://www.g-w.com)