

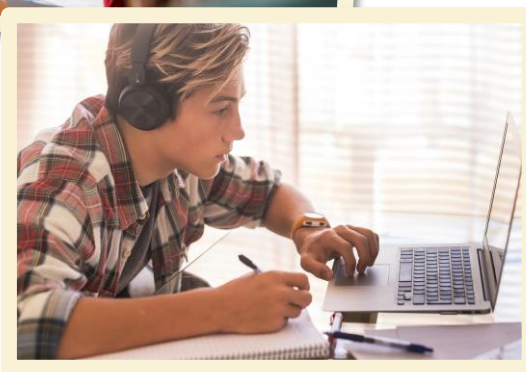
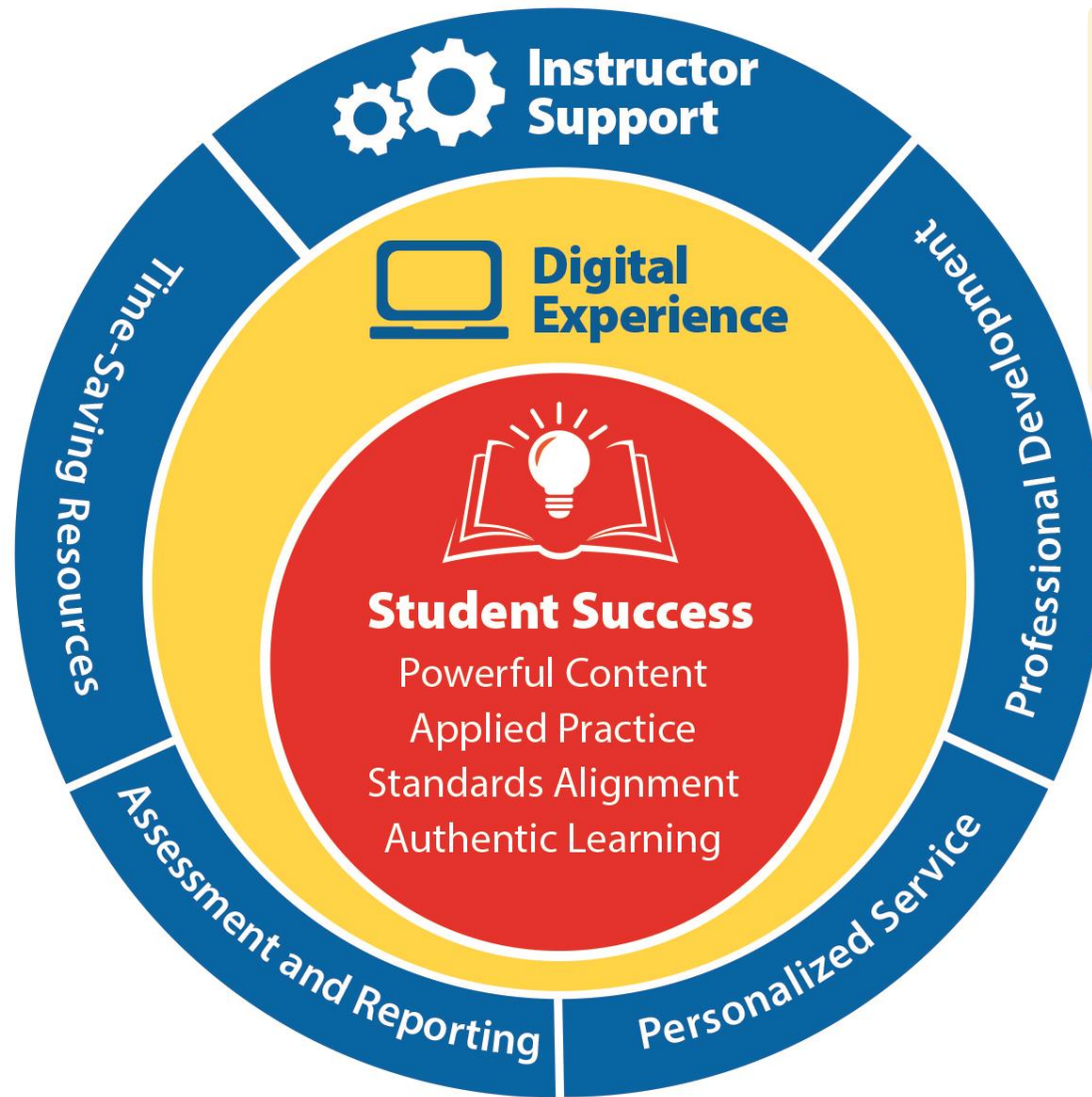
Metallurgy Fundamentals

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*Shown are examples across various titles

- ✓ Prepare for class
- ✓ Reinforce new concepts
- ✓ Assess learning

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Metallurgy Fundamentals: Lesson Plan

Instructor:
Course:

Date:
Unit:

Chapter 5: Basic Structure of Metals

Chapter Objectives

- (Obj 5.1) Define *atom*, *element*, and *compound*.
 - 5.2 Atomic Elements
 - 5.3 Compounds
- (Obj 5.2) Recognize the relative sizes of atoms, compounds, and crystal grains.
 - 5.1 Measurement Scales
 - 5.3 Compounds
 - 5.5 Crystal Structures
- (Obj 5.3) List the four properties that distinguish metals from nonmetals.
 - 5.4 Formation of Metals
- (Obj 5.4) Distinguish between the three major crystal structures found in metals: face-centered cubic, body-centered cubic, and hexagonal close-packed.
 - 5.5 Crystal Structures
- (Obj 5.5) Name metals with each of the three major crystal structures: face-centered cubic, body-centered cubic, and hexagonal close-packed.
 - 5.5 Crystal Structures
- (Obj 5.6) Understand how metals can be deformed without fracturing.
 - 5.4 Formation of Metals
 - 5.5 Crystal Structures
- (Obj 5.7) Distinguish between a solid solution and an alloy.
 - 5.6 Compounds, Mixtures, Solutions
- (Obj 5.8) Understand and identify the types of intermetallic compounds.
 - 5.5 Crystal Structures
- (Obj 5.9) Understand how the terms *alloy*, *intermetallic compound*, and *solid solution* are used.
 - 5.6 Compounds, Mixtures, Solutions

Essential Question

Can you describe the basic structure of metals and how it defines the properties of metals? How do these properties apply to metals?

Instructional Resources

- Textbook/eBook: Chapter 5
- Instructor Resources: Chapter 5 Introduction
- Instructor Resources: Chapter 5 Assessment
- Other instructional resource:

Resources for Practice and Application

Assessment Software & Question Pools

ExamView® Assessment Suite v11 Software and Question Bank Files

The ExamView® Assessment Suite allows you to quickly and easily create, administer, and score paper and online tests. The ExamView® Assessment Suite includes the ExamView® Test Generator, ExamView® Test Manager, and ExamView® Test Player. G-W test banks are installed simultaneously with the software. If you cannot locate the test banks after installation, please refer to the ["How do I locate the ExamView® v8.1 or later test banks on my computer after installation?"](#) FAQ.

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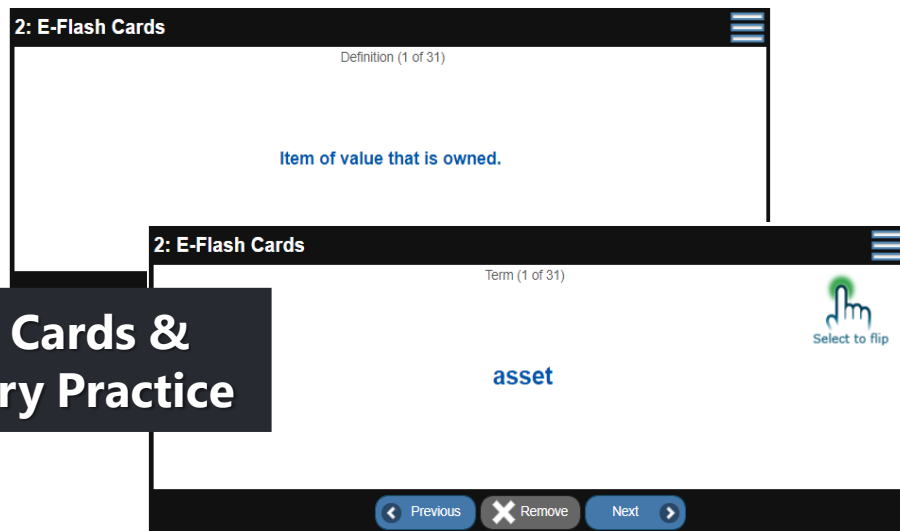

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CERTIFIED


Google Classroom

LMS and CMS Integration Easy Navigation

*Shown are examples across various titles



E-Flash Cards & Vocabulary Practice

2: Vocabulary Game

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

Score: 800

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

Definition: Act of giving money, goods, or services to meet the needs of others and support causes that are important to an individual.

- ☐ pay yourself first
- ☐ variable expense
- ☐ recordkeeping
- ☒ philanthropy

Check Answer

Interactive Activities

Metallurgy Fundamentals: Lab 7

Name:

Date:

Class:

Lab 7: Metal or Nonmetal?

Introduction

Chapter 5 of the textbook states that if a material is a metal, it has all four properties shared by metals:

- Electrical conductivity
- Thermal conductivity
- Formability, or the ability to deform without cracking
- Reflectivity, or shininess

Some materials have some of these properties, but only metals have all four. Thermal conductivity is closely related to electrical conductivity, so you can skip complex tests for that property in this lab.

Objectives

- Identify metals and nonmetals using the four fundamental physical properties of all metals.
- Understand that some composite and coated items may be tricky to discern.

Safety Considerations

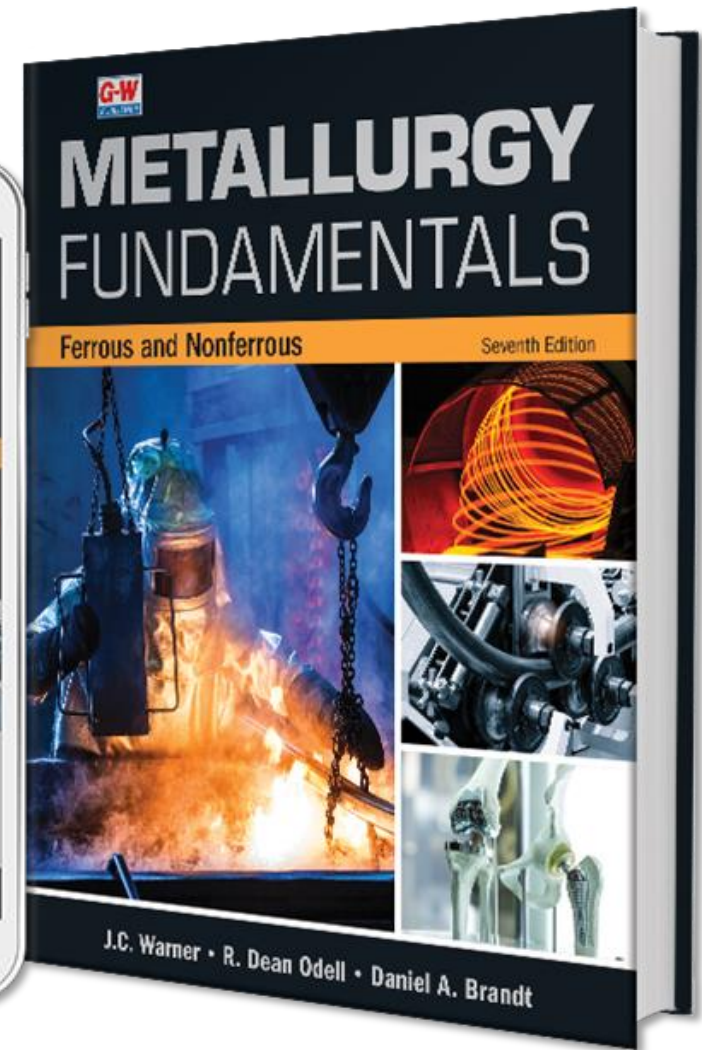
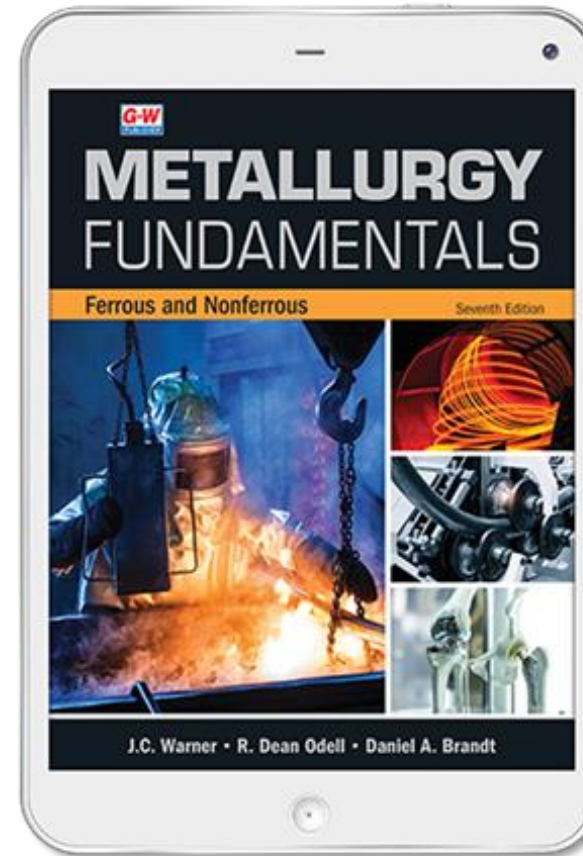
- Wear safety glasses or goggles when smashing things, especially ceramics and rocks, and tap them just hard enough to bend, dent, or break.
- The drinking glass has already been tested for you, so you do not need to break yours. The glass did not bend. You can test your glass for conductivity without breaking it.

Equipment

- Safety glasses or goggles
- A multimeter that can read electrical resistance
- A hammer and an anvil or hard surface
- A piece of fine sandpaper (emery board will work)
- Polishing compound and buffing cloth, such as for polishing automobiles (copper

Lab Manual Activities

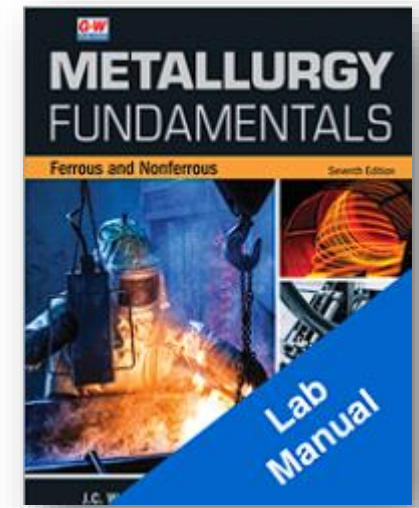
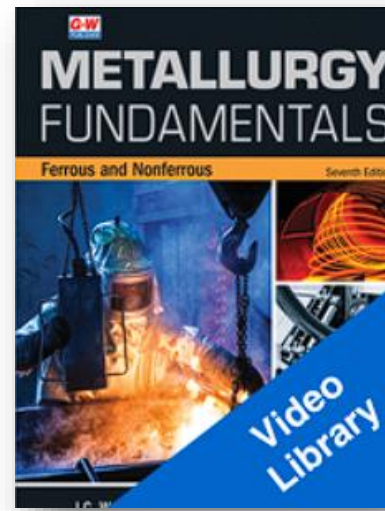
Integrate G-W Digital Resources



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NEW



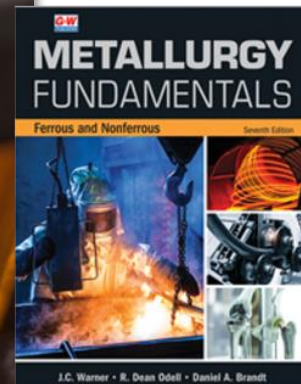
CHAPTER 4
Mechanical Properties of Metals



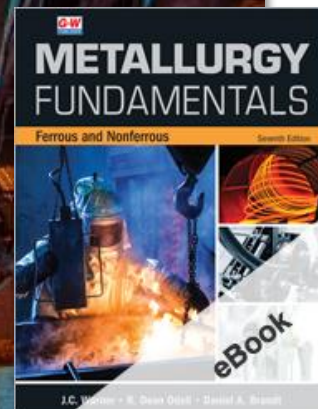
CHAPTER 5
Basic Structure of Metals



CHAPTER 6
Physical and Chemical Properties of Metals



What's New to the Edition



Section 1—Introduction to Metallurgy

- 1 History of Metallurgy
- 2 Metallurgists and Careers in Metals Industries
- 3 Metallurgy Safety Practices

Section 2—Mechanics and Chemistry of Metals

- 4 Mechanical Properties of Metals
- 5 Basic Structure of Metals
- 6 Physical and Chemical Properties of Metals

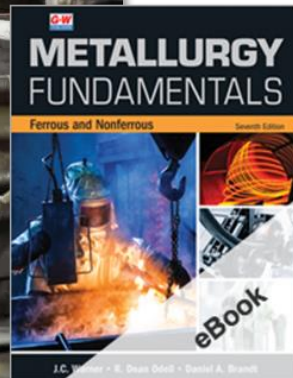
Section 3—Ferrous Metallurgy

- 7 Production of Steel by Hot-Rolling
- 8 Production of Steel by Casting, Forging, Extrusion, and Powder Metallurgy
- 9 Processing Steel to Finished Products
- 10 Phase Diagram: Road Map to Phases, Structures, and Properties
- 11 Heat-Treating Steels for Strength, Toughness, and Ductility
- 12 Heat-Treating Heavy Sections
- 13 Surface Heat Treatment and Specialty Alloys
- 14 Production of Cast Iron

Section 4—Nonferrous Metallurgy

- 15 Introduction to Nonferrous Metals
- 16 Aluminum
- 17 Copper, Bronze, and Brass
- 18 Titanium
- 19 Low-Density Metals: Magnesium, Beryllium, and Lithium
- 20 High-Density Metals: Zinc, Tin, Lead, Mercury, and Uranium
- 21 Superalloys and Refractory Metals
- 22 Noble and Rare Earth Metals

Student Textbook



CHAPTER OUTLINE

- 1.1 The Bronze Age**
 - 1.1.1 Alloying
 - 1.1.2 Early Smithing
- 1.2 The Iron Age**
 - 1.2.1 Wrought Iron and True Steel
 - 1.2.2 Cast Iron
 - 1.2.3 Iron and Steel in Medieval Europe
 - 1.2.4 Iron in the New World
- 1.3 Industrial Revolution**
 - 1.3.1 Nineteenth-Century Developments
 - 1.3.2 Twentieth-Century Developments
- 1.4 Twenty-First-Century Developments**
 - 1.4.1 Additive Manufacturing
 - 1.4.2 Computer Simulations
 - 1.4.3 Nanomaterials
 - 1.4.4 Reducing Greenhouse Gases

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

- Identify the metals archaeologists and historians consider most important in the
- Understand the human effort required to make iron and steel before the 1800s.
- Define the term *wrought iron*.
- Explain why the development of the Bessemer converter promoted the industria
- Recognize how the development of electric generators created the need for high-
- Understand how the Hall-Héroult process for refining aluminum changed appli
- Describe the developments in steelmaking over the last 60 years that allow steel
- Understand that innovations and improvements in metal production and applic

TECHNICAL TERMS

- additive manufacturing
- alloying
- basic oxygen furnace (BOF)
- Bessemer converter
- bloom

Chapter-Opening Material



SAFETY NOTE

Hexavalent Chromium

Chromium is used in stainless steel, plated onto the surface of steel, and sometimes added to alloy steel. some stainless steel welding. When all six outer electrons are involved in a reaction, it results in *hexavalent* working nearby must be protected from fumes.

PRACTICAL METALLURGY

Absorbing Stress and Strain: A Platform Trailer

The implications of stress and strain become clear with a practical example in the platform, as shown in **Figure 4-7**. This helps them absorb the stress

DID YOU KNOW?

Scientific Notation

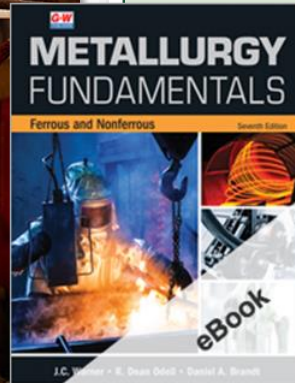
When a number is written as a product consisting of the number multiplied by a power of 10, this is known as scientific notation. the left to get the decimal number. So:

$$1.0 \times 10^{-3} = .001$$

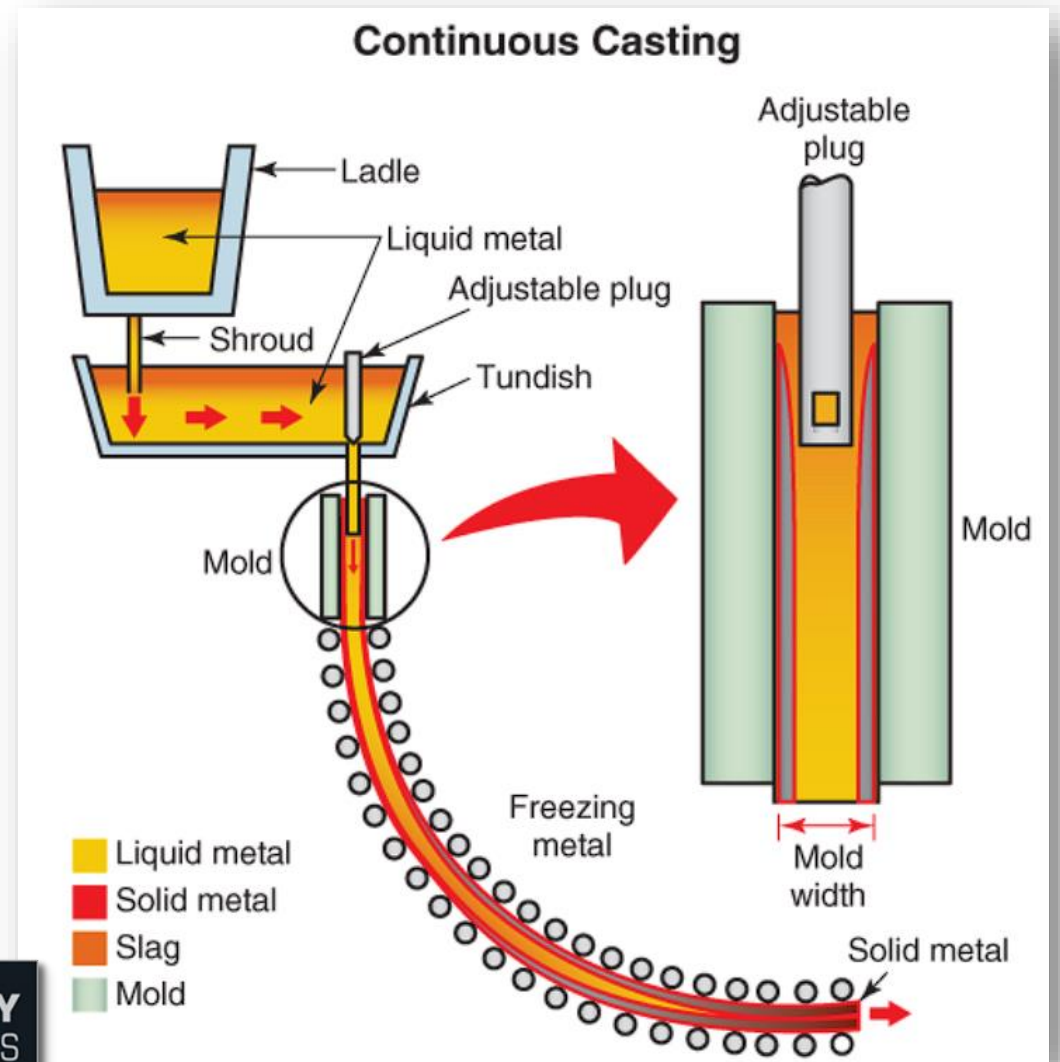
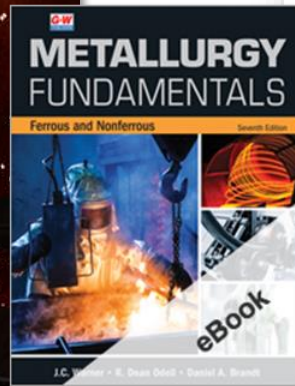
SUSTAINABLE METALLURGY

Reducing Waste from Ore Processing

left over from processing must be sequestered, or set aside and protected, so that rainwater runoff at causes lung cancers similar to those caused by asbestos. When economically viable, gangue is from the initial mining of taconite ore must also be sequestered to minimize effects on local v which can destroy the downstream environment. However, once a mine is closed, overburden can oft



Additional Features



Illustrations

Review Questions

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

Know and Understand

- 1. True or False? A malleable metal is *not* capable of being shaped.
- 2. True or False? Archaeologists typically map ages of a civilization by the most significant material involved.
- 3. During the Bronze Age, _____ was made into decorative items due to its resistance to tarnishing.
 - A. bronze
 - B. copper
 - C. gold
 - D. tin
- 4. True or False? Meteoric iron was highly prized due to its ability to be worked into strong, tough tools with sharp cutting edges.
- 5. The matter remaining once a metal has been separated from its ore is known as _____.
 - A. bloom
 - B. slag
 - C. wootz steel
 - D. ingot
- 6. Cast iron ingots are also known as _____ iron.
 - A. puddle
 - B. bog
 - C. pig
 - D. wrought
- 7. Bloomeries were the earliest furnaces used to produce _____ iron from the ore.
 - A. wrought
 - B. pig
 - C. bog
 - D. puddle
- 8. True or False? Wrought iron can be treated to obtain a much higher strength than true steel.
- 9. Since it contains a large amount of sulfur, _____ iron will crack if forged while hot.
 - A. pig
 - B. bog
 - C. wrought
 - D. puddle

Apply and Analyze

- 1. What is the difference between *smelting* and *alloying*?
- 2. Describe the process used to produce *wrought iron*.
- 3. How did the invention of the Bessemer converter influence the development of an industrialized society?
- 4. Explain how the conception of electric generators created the need for high-purity copper and simultaneously made it commercially possible.
- 5. List three advantages a *basic oxygen furnace (BOF)* has over an open-hearth furnace.

Critical Thinking

- 1. How did the tin trade promote cultural development throughout the western world?
- 2. Nearly every kind of manufacturing today is affected by the behavior of metals. How does this affect the need for a study of metallurgy?
- 3. Each steelmaking process has required alert, knowledgeable people to operate it. How is that also true when robots are used?

Metallurgy Fundamentals ©2025, End of Chapter Review Questions

Chapter 1: History of Metallurgy

Review Questions

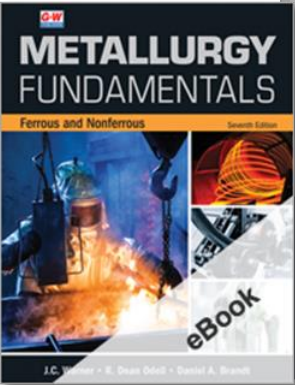
Instructions: Answer the following questions using the information provided in this chapter.

Know and Understand

- 1. True or False? A malleable metal is *not* capable of being shaped.
Answer:
- 2. True or False? Archaeologists typically map ages of a civilization by material involved.
Answer:
- 3. During the Bronze Age, _____ was made into decorative items due to tarnishing.
 - A. bronze
 - B. copper
 - C. gold
 - D. tin
Answer:
- 4. True or False? Meteoric iron was highly prized due to its ability to be worked into strong, tough tools with sharp cutting edges.
Answer:
- 5. The matter remaining once a metal has been separated from its ore is known as _____.


1 History of Metallurgy ▼

- E-Flash Cards
- Matching Activity
- Vocabulary Game
- Review (DOCX, 31 KB)



End-of-Chapter Content

Activities ▼

- [DOCX](#) Lab 1: Hardness Testing of Steel
- [DOCX](#) Lab 2: Measuring Rockwell Hardness with Different Scales
- [DOCX](#) Lab 3: Determining Hardness and Alloy Type by Spark and File Tests
- [DOCX](#) Lab 4: Hardness Testing of Thin Sheet
- [DOCX](#) Lab 5: Hardness Testing of Castings
- [DOCX](#) Lab 6: Tensile Testing of Steel
-  [DOCX](#) Lab 7: Metal or Nonmetal?
- [DOCX](#) Lab 8: Metallurgical Specimen Preparation
- [DOCX](#) Lab 9: Ductile-to-Brittle Transition Temperature of Steel
- [DOCX](#) Lab 10: Hardenability of Steel
- [DOCX](#) Lab 11: Tempering Martensite
- [DOCX](#) Lab 12: Effects of Annealing on Cold-Worked Brass
- [DOCX](#) Lab 13: Determining Strength of a Weld
- [DOCX](#) Lab 14: Age Hardening of Aluminum
- [DOCX](#) Lab 15: Pack Carburizing of Steel
- [DOCX](#) Lab 16: Strain-Hardening Copper Wire



Name:

Date:

Class:

Lab 7: Metal or Nonmetal?

Introduction

Chapter 5 of the textbook states that if a material is a metal, it has all four properties shared by metals:

- Electrical conductivity
- Thermal conductivity
- Formability, or the ability to deform without cracking
- Reflectivity, or shininess

Some materials have some of these properties, but only metals have all four. Thermal conductivity is closely related to electrical conductivity, so you can skip complex tests for that property in this lab.

Objectives

- Identify metals and nonmetals using the four fundamental physical properties of all metals.
- Understand that some composite and coated items may be tricky to discern.

Safety Considerations

- Wear safety glasses or goggles when smashing things, especially ceramics and rocks, and tap them just hard enough to bend, dent, or break.
- The drinking glass has already been tested for you, so you do not need to break yours. The glass did not bend. You can test your glass for conductivity without breaking it.

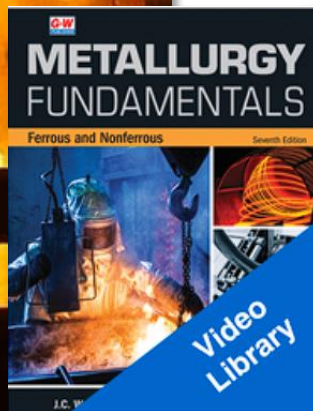
Equipment

- Safety glasses or goggles
- A multimeter that can read electrical resistance in ohms
- A hammer and an anvil or hard surface to pound on
- A piece of fine sandpaper (emery board will work)
- Polishing compound and buffing cloth, such as for polishing automobiles (copper or silver polishing compound will also work)

Materials

- Find at least 15 items to test for metallic properties, including the first five from

Lab Manual



Heat-Treating Samples for Hardness Tests



[Hide transcript](#)

Transcript

Heat-Treating Samples for Hardness Tests

In this lab, we're going to do a little bit of heat treating of some specimens for a Rockwell test. Now, what I have here are little one-inch rounds. These are all cut on a band saw from, you know, round stock from McMaster-Carr. This is 1045 steel. Now, this is all I'm going to be putting in this oven for right now, but when we get to batches of mixed materials, if I was putting the same size puck that's got some 1045, 01, W1, and whatnot, it's very difficult to keep track of what is what. Paint marker or Sharpie is going to burn off in the oven. You can etch, if you want. Sometimes there's so much mill scale, a light etch will just flake right off, too. One way to do it is with a hammer and a punch that can give you a good marking.

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Type: Downloadable Activities

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Snap, Clap, Pop: Health Skills for High School

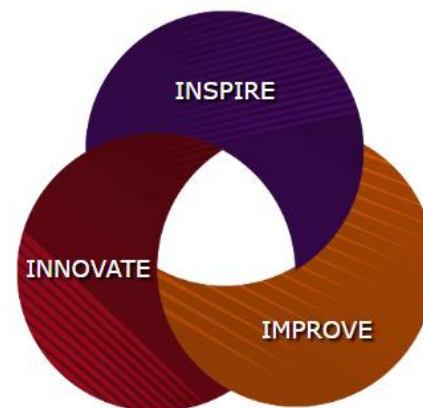
First Day Icebreakers

Snap, Clap, Pop: Animal Science

www.g-w.com/tools-for-educators



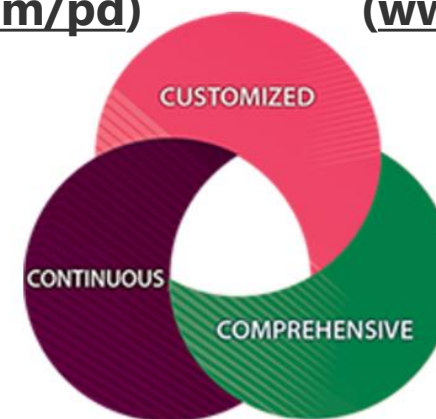
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