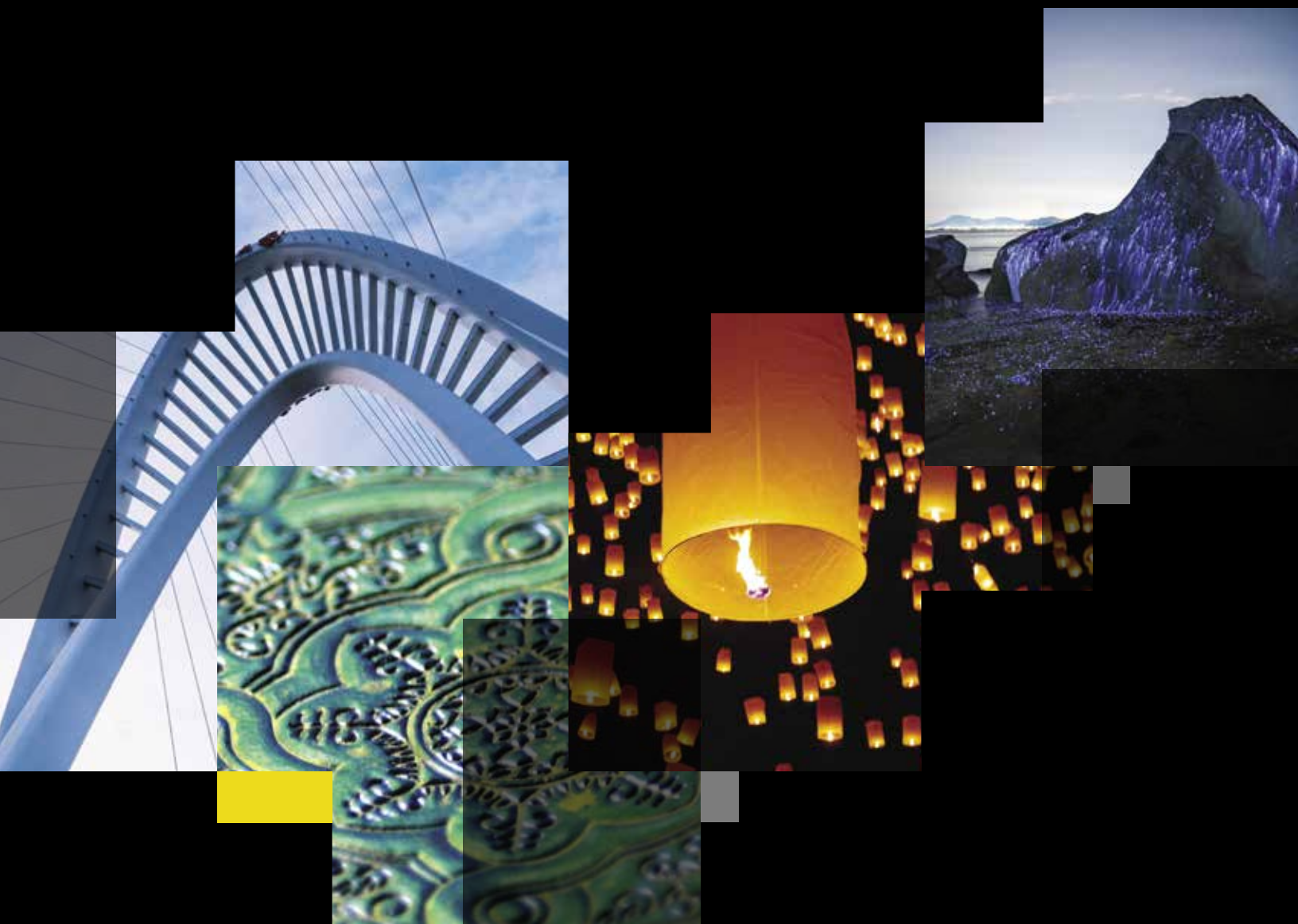


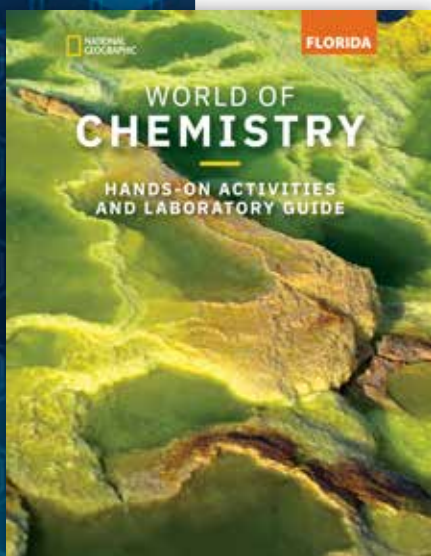
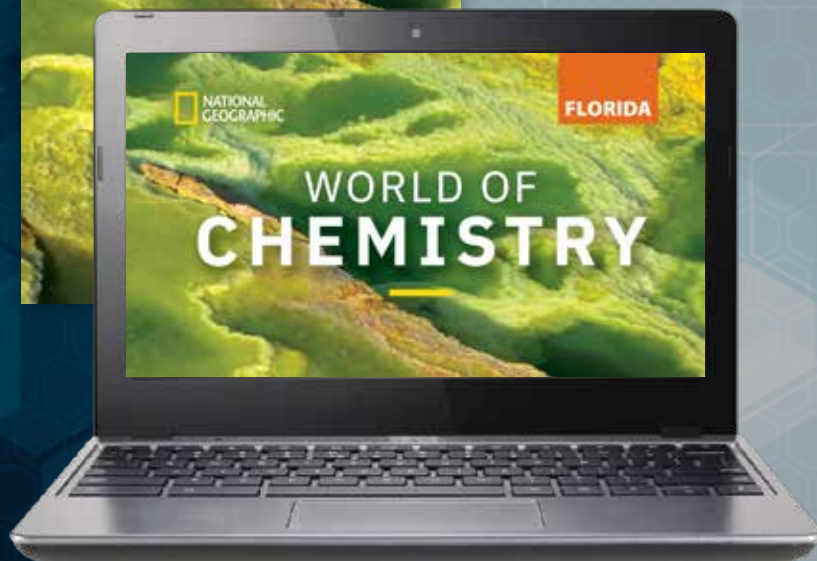
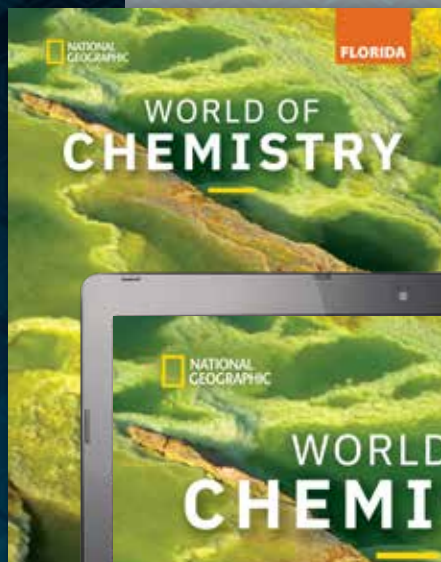
# WORLD OF CHEMISTRY

Florida Edition



# PUT STUDENTS AT THE CENTER OF CHEMISTRY LEARNING

Activate student curiosity and thinking with *National Geographic Explorers* and visuals that tell the story of how chemistry is critical to daily life. Each lesson provides multiple opportunities for students to build problem-solving skills through the exploration of science.



## Get to the heart of “Why learn Chemistry?”

Students will think like chemists to create real-world solutions for projects in the *World of Chemistry Activity Guide, Florida Edition* activities inspire group discussions to help students get to the deeper meaning and importance of chemistry concepts.

Students use chemistry knowledge to design, build, and test solutions during four activity challenges.





# ENGAGE STUDENTS WITH REAL-WORLD CHEMISTRY STORIES

## Chemistry 5E Lesson Design

### ENGAGE

3D Lesson Design  
Real World Issues & Phenomena  
Driving Question  
Active Learning Lessons

### EXPLORE/EXPLAIN

Media Library  
Group Discussion Activities  
Simulations  
Modeling Tools  
Core Ideas & Skills Lessons  
Laboratory Experiment  
Explorers At Work  
Exploring Engineering  
Chemistry In Your World

### ELABORATE

Activity Guide  
Hands On Labs  
Laboratory Experiments  
Solving Everyday Problems  
Engineering Practices  
Developing Solutions  
Case Study

### EVALUATE

Lesson Checkpoints  
Formative Assessments  
Summative Assessments  
Chapter Investigations

## Chemistry in Your World

### Developing Smart Solutions to Ocean Plastic

Discarded fishing nets have become a global issue as a source of plastics in our oceans. This issue is particularly problematic in coastal communities in Southeast Asia, where families depend on fishing for survival. Residents often have no sustainable way to dispose of used nets. Nets discarded into the ocean can damage coral reef habitats while continuing to entrap and kill fish and other animals in the ecosystem.

National Geographic Explorer Heather Koldewey is working to provide innovative solutions to this problem in the Philippines. With her award-winning project Net-Works, she has developed a community-based solution for collecting discarded fishing nets. Taking advantage of plastic's versatility, the nets retrieved by local community members can be recycled into high-quality nylon yarn. The yarn is used to make carpet tiles that are sold around the world. This provides a new source of income to coastal

communities while helping to remove the discarded nets from the environment. So far, the organization has helped to collect over 224 metric tons of fishing nets—enough to circle the world more than five times!

The organization is also helping communities to establish Marine Protected Areas (MPAs), no-fishing zones in order to protect natural resources and endangered coral reef, seagrass, and mangrove habitats. Sustainable seaweed farms have been established to double as “biofence” barriers



**FIGURE 1-15**  
National Geographic Explorer Heather Koldewey

area. Plans for additional large

## Chemistry in Your World features real-world applications of chemistry in a variety of fields.

Ne prototyped the first large-scale community-based MPA that was able to replenish fish stocks in the

smart thinking and a systematic approach.

**FIGURE 1-16**  
Community members harvest seaweed from an MPA biofence farm in the Philippines.



### Rules for Naming Alkanes

1. Find the longest continuous chain of carbon atoms. This chain (called the parent chain) determines the base alkane name.
2. Number the carbons in the parent chain, starting at the end closest to any branching (the first alkyl substituent). When a substituent occurs the same number of carbons from each end, use the next substituent (if any) to determine from which end to start numbering.
3. Using the appropriate name for each alkyl group, specify its position on the parent chain with a number.
4. When a given type of alkyl group occurs more than once, attach the appropriate prefix (di- for two, tri- for three, and so on) to the alkyl name.
5. The alkyl groups are listed in alphabetical order, disregarding any prefix.

## Chemistry in Your World

### Livestock and Methane Production

Methane is the second-biggest factor in greenhouse gas emissions. Though methane has a much shorter lifetime in the atmosphere than carbon dioxide (the most common greenhouse gas), it is much more efficient at trapping radiation. It has a global warming potential 28 times greater than that of carbon dioxide when compared over the course of a 100-year period.

The production and transport of petroleum and other fossil fuels often release methane. Another significant but often overlooked source of methane emissions is the agricultural industry. Livestock such as cows, sheep, and goats produce large volumes of methane as microbes in their guts break down nutrients during digestion. This methane is mostly released when the animals burp, sending it into the atmosphere.

The thought of burping cows may seem humorous, but these emissions have a serious impact on the environment. As global demand for livestock exposures has increased in recent years, agricultural methane emissions have also increased significantly. Scientists are currently working on solutions to reduce livestock methane emissions. One area of research has involved modifying cows' diets to produce less gas.

Another has involved breeding cows that are genetically predisposed to have fewer of the methane-producing microbes in their digestive systems. Researchers think it could be possible to selectively breed livestock until agricultural methane emissions are a problem of the past.

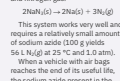


## Chemistry in Your World

### The Chemistry of Air Bags

In addition to seat belts, air bags are an important component of automobile safety. Frontal air bags were first widely adopted in U.S. vehicles in 1987 and have saved over 50,000 lives since then. Air bags, which are stored within the car's steering wheel, dashboard, seats, or roof panels, are designed to inflate within about 40 milliseconds in the event of a crash, cushioning the occupants against impact. The bags then deflate immediately to allow vision and movement after the crash.

Air bags are activated when a sensor designed to detect severe deceleration sends an electrical signal to ignite a detonator cap. The detonation causes sodium azide ( $\text{NaN}_3$ ) to decompose explosively, forming solid sodium and nitrogen gas:



activators must be disposed of properly. Sodium azide, besides being explosive, is toxic.

**FIGURE 1-22**  
An inflated air bag contains nitrogen gas.



**Molar Volume** It is useful to define the **molar volume** of a gas as the volume occupied by 1 mole of the gas under certain specified conditions. Properties of gases are often given at 0 °C and 1 atm. These conditions are called **standard temperature and pressure** (abbreviated **STP**).

For 1 mole of an ideal gas at 0 °C (273 K) and 1 atm, the volume of the gas given by the ideal gas law is

$$V = \frac{nRT}{P} = \frac{1.00 \text{ mol} (0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}) (273 \text{ K})}{1.00 \text{ atm}} = 22.4 \text{ L}$$

The molar volume of an ideal gas is 22.4 L at standard temperature and pressure. In other words, 22.4 L contains 1 mole of an ideal gas at STP.

### Example 13.15

#### Gas Stoichiometry: Calculations Involving Gases at STP

**Calculate** A sample of nitrogen gas has a volume of 1.75 L at STP. How many moles of  $\text{N}_2$  are present?

**Solution**

**What Do We Want to Find?**

Amount of  $\text{N}_2$  = ? mol

**What Do We Know?**

$V = 1.75 \text{ L}$  at STP

$n = 22.4 \text{ L}$  at STP

**How Do We Get There?**

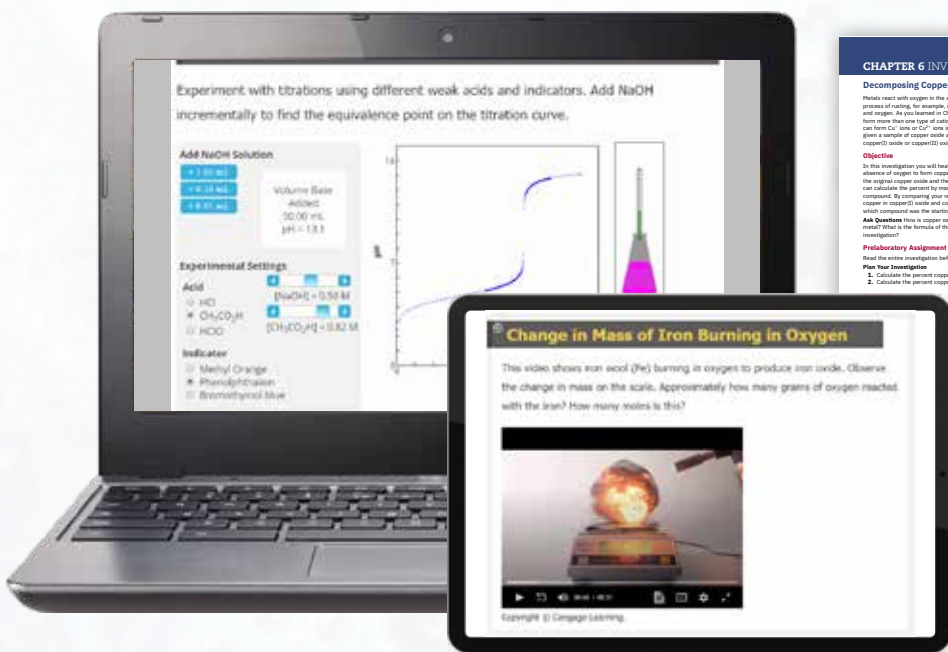
We could solve this problem by using the ideal gas equation or by using the molar volume of an ideal gas at STP. Because 1 mole of an ideal gas at STP has a volume of 22.4 L, a 1.75-L sample of  $\text{N}_2$  at STP contains considerably less than 1 mole. We can find how many moles by using the equivalence statement

$$1.00 \text{ mol} = 22.4 \text{ L at STP}$$

Chemistry in Your World explores real-world applications in chemistry



# TAKE STUDENTS ON A CHEMISTRY JOURNEY



### CHAPTER 6 INVESTIGATION

#### Decomposing Copper Oxide

Metals react with oxygen in the air to form metallic oxides. The process of rusting, for example, involves the reaction of iron and oxygen. As you learned in Chapter 5, many metals can form more than one type of oxide. For example, copper (Cu) can form Cu<sub>2</sub>O or CuO. In a zinc compound, you can tell if you've given a sample of copper oxide and will determine whether it is copper(I) oxide or copper(II) oxide.

**Objective**  
In this investigation you will heat copper oxide powder in the absence of oxygen to form copper metal. From the masses of the original copper oxide and the copper metal you obtain, you can calculate the percent by mass of copper in the original compound. By comparing your result to the percent by mass of copper in copper(I) oxide and copper(II) oxide, you can decide which compound was the starting material.

**Ask Questions** How is copper oxide formed from copper metal? What is the formula of the copper oxide used in this investigation?

**Prelaboratory Assignment**  
Read the entire investigation before you begin.

**Plan Your Investigation**  
1. Calculate the percent copper by mass in copper(I) oxide.  
2. Calculate the percent copper by mass in copper(II) oxide.

**Hands-on Chemistry**

**Relative Masses**

**Materials**  
cotton balls  
paper clips  
rubber stoppers  
balance  
ruler

**Procedure**  
1. Obtain cotton balls, paper clips, and rubber stoppers from your teacher.  
2. Devise a method to find the average mass of each of these objects. Discuss this method with your teacher.  
3. Copy the table onto your paper. Determine the average mass of each object. Record the average mass of each of the objects in your table.

Relative Masses	Mass of one object	Relative mass of one object	Mass of n objects
cotton balls	g		lb
paper clips	g		lb
rubber stoppers	g		lb

**Analysis**  
1. Compare the lightest object's relative mass to 1.0 in your table. Determine the relative mass of the remaining objects, and record these in your table.  
2. Calculate how many of the lightest object would you need to have a pound of that object? Call this number *n*.  
3. Calculate if you had *n* of each of the other objects, how much would each sample weigh? Fill these numbers into your table.  
4. Analyze Determine which column corresponds to the chemical formula "atomic mass" and "molar mass."  
5. Interpret Which number represents "Avogadro's number"?

Hands-on labs, investigations, projects, and digital simulations provide experiences to move students towards true understanding. Students apply 3-dimensional practices, collect and analyze data, and think creatively to solve chemistry problems.

### Case Study

#### Solving the Plastic Problem

The strength of the substitution bonds that make up the polymer chains in plastics makes them difficult to biodegrade. This makes plastic-based products very durable. It also means that plastic objects can take more than 450 years to decompose. Once plastic is in the environment, it remains there for a long time. This has serious implications: more than 40 percent of plastic items are used just once and then thrown away. This leads to overflowing landfills and contaminated waterways. Scientists estimate that more than eight million tons of plastic waste end up in the oceans each year, posing a threat to hundreds of species of marine animals.

Scientists and engineers are working to develop solutions to decrease the problem caused by plastic's durability. One easy solution is reuse and recycling. Plastic objects can be reused rather than thrown away. Some types of plastic can be recycled up to six times instead of being discarded in a landfill. Plastics that cannot be reused or recycled can be combined to generate energy.

Unfortunately, less than 20 percent of the plastic generated globally gets recycled, and an even smaller percentage is recycled in the United States. One alternative to petroleum-based plastics are bioplastics, plastics that are made from renewable biomass resources. Source materials for such plastics include corn starch, vegetable oils, food waste, and agricultural waste. Many bioplastics degrade more easily than traditional plastics. However, experts debate their usefulness as a solution to the problem of global plastic waste. Growing plants for bioplastics may reduce crop growth for food resources. Packaging made from biodegradable plastic also has a much shorter shelf life. For these and other reasons, bioplastics have not been widely embraced as an alternative to petroleum-based plastics.

Another solution being investigated involves the use of plastic-eating bacteria. Scientists have isolated a strain of bacteria that is able to give polylactide terephthalate (PET), a plastic

in single-use beverage bottles. These bacteria appear to have evolved to produce an enzyme able to break down PET. Scientists think this enzyme could be used for "bio-recycling." Much further study must be completed before this is considered a viable waste solution.

Decreasing our dependence on plastic packaging seems to be the only feasible way to reduce plastic pollution globally. In the meantime, experts agree that the best current solution to the plastic problem is to reuse and recycle the plastic we already have.

**Evaluate Solutions**  
Research the plastic disposal systems in your community. Then prepare an informative brochure or website proposing how the plastic recycling program in your school or community could be improved.

**FIGURE 20-47**  
The amount of plastic produced in the world has increased steadily in the second half of the 20th century.

CHAPTER 20 CASE STUDY 779

### Case Study

#### The Flint Water Crisis

In 2014 the city of Flint, Michigan, changed the source of its drinking water from Lake St. Clair and the Detroit River to water from the Flint River. Flint is using the new water source. Flint is not just to pay for the water, which means the water has less expense. But the change came with a hidden cost. Detroit carefully treated its drinking water to remove harmful contaminants. The water from the Flint River did not receive the same treatment. It was also more acidic.

Flint, like many older cities, had lead pipes in their water delivery network. Prior to 2014, the water Flint was using was treated with phosphate corrosion inhibitors, which produce phosphate ions (PO<sub>4</sub><sup>3-</sup>) in solution. Phosphates react with lead to form lead(II) phosphate (Pb<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>), which creates an insoluble barrier and makes water less likely to corrode the pipes. This crust reduces the amount of lead that comes into contact with the water. When the source of water changed, officials did not use an adequate precaution.

As a result, levels of bacteria skyrocketed. Flint residents began complaining that their water gurgled sick. City officials told them to boil their water to kill the bacteria.

They still had not recognized the source of the problem. The cause of the crisis was first identified by scientists, but by a citizen named Leshona Walker. She knew something was wrong with the water, so she got the city to test it. She learned that the lead levels were very high. She contacted scientists at Virginia Polytechnic Institute and State University, which collected hundreds of samples in 15 days per billion (ppb). In Flint, lead levels were greater than 2000 ppb in some samples. The corrosion inhibitors of the protective crust affected iron pipes as well. Flintans drawn from natural sources or after treated with chlorine (Cl<sub>2</sub>) to kill bacteria such as E. coli, some strains of which can cause severe gastrointestinal infections. Elemental chlorine creates an acidic solution and makes water less likely to corrode the pipes to release the water. What water fills did provide corrosion when drinking an effective disinfectant.

As a result, levels of bacteria skyrocketed. Flint residents began complaining that their water gurgled sick. City officials told them to boil their water to kill the bacteria.

**FIGURE 20-48**  
Flint residents received a magnesium fluoride pipe in the first week of 2015. On some days, a batch of five pipes was replaced with a new pipe. On other days, only one pipe was replaced. The pipes in Flint were replaced at five-week intervals.

CHAPTER 20 REACTIONS IN AQUEOUS SOLUTIONS 285

A Case Study at the end of each chapter takes an in-depth look at a real-world issue or topic related to the chapter content. Each Case Study culminates with a student activity.

# BUILD STUDENT PROBLEM-SOLVING SKILLS AND STRATEGIES

## Where Do We Want To Go?

Clearly state the problem in terms of the goal or what we're trying to do.



## What Do We Know?

Related facts we know that provide a starting point.



## How Do We Get There?

The program provides tools to students for taking what we know and moving through towards the solution goal.



## Does It Make Sense?

Test that the solution is reasonable based on what we know.

Prepare students for college and careers by setting a foundation in *World of Chemistry* for students to think critically about chemistry and science issues and to practice strategies for solving problems inside and outside the chemistry classroom.

## Guidance

A four-step problem solving approach is introduced to consistently guide students to understand what chemistry problems require to get to a solution that makes sense.

**EXPLORERS AT WORK**

### Improving Nuclear Power

with National Geographic Explorer Leslie Dewan

We have known for nearly a century that nuclear reactions can be harnessed as a tremendous source of energy. Nuclear power plants operate similarly to traditional fossil fuel plants. The heat from a reaction is used to generate steam. The steam then powers a turbine that produces electrical power. There has been a decrease in the use of nuclear power in the United States over recent decades. This is due to the availability of relatively affordable power from natural gas, as well as societal concerns over the safety and environmental impacts of nuclear power. National Geographic Explorer Leslie Dewan is hoping to regenerate the nuclear industry and change society's perceptions of nuclear power.

Nearly all nuclear reactors in operation today are based on the same general process: The energy that results from nuclear reactions in solid pellets of uranium oxide is used to boil water and generate steam that powers an electrical turbine. However, some of the earliest nuclear reactor designs used uranium dissolved in molten salt. Heat from nuclear reactions in the molten salt mixture can then be used to produce steam and generate electricity. Dewan and a team of engineers have developed the design for modern molten salt reactors that would decrease waste production, improve safety, and increase the efficiency of nuclear power. In traditional reactors, the waste products of the nuclear reaction build up in the fuel elements over time. This buildup decreases the efficiency of the reaction. The metal structure that holds the uranium oxide in place is also gradually damaged as the reaction progresses. The fuel in a traditional reactor can only remain in use for about four years, after which it must be discarded.

In a molten salt reactor, the waste products of the reaction can simply be filtered out of the liquid solution. Because the uranium is suspended in a liquid instead of being held in place by metal, structural damage is minimized. This means the fuel can be used for decades, so much more of the available energy can be extracted before disposing of the uranium. The result is that far less nuclear waste is generated in the process.

Molten salt reactors are also potentially safer than traditional reactors. Traditional reactors operate at extremely high pressures. The rare catastrophic explosions that have occurred at nuclear plants are usually the result of the release of built-up pressure. The sudden release sprays nuclear waste into the surroundings. Molten salt reactors operate at atmospheric pressure, making them less likely to release waste into the environment should an accident occur.

Dewan and the team have made their research available to the public with the hope that it will inspire a new generation of nuclear engineers. "Climate change is real," she says. "Novel nuclear technologies present the best way to address the issue, by rapidly expanding carbon-free energy at scale and making fossil fuels a thing of the past."

**Thinking Critically**  
**Evaluate** As you read the chapter, gather evidence to explain how nuclear reactors work. How could nuclear power be used as a replacement for traditional fossil fuels? Is nuclear power a sensible large-scale solution to the world's growing power needs?

**Critical Thinking**

51. What is the difference between the atomic number and the mass number of an element? Can atoms of two different elements have the same atomic number? Could they have the same mass number? Explain.

52. Which subatomic particles contribute most to the atom's mass? Which subatomic particles determine the atom's chemical properties?

53. Is it possible for the same two elements to form more than one compound? Is this possibility consistent with Dalton's atomic theory? Give an example.

54. Write the simplest formula for each of the following substances, listing the elements in the order given.

a. a molecule composed of one carbon atom and two oxygen atoms  
b. a compound consisting of one aluminum atom for every three chlorine atoms  
c. peracetic acid, which consists of one hydrogen atom, one chlorine atom, and four oxygen atoms  
d. a molecule composed of one sulfur atom and six chlorine atoms

55. List the charges of the ions formed from atoms in each of the groups.

56. An ion has a charge of  $2-$  and 28 electrons. From which atom does this ion form?

57. Consider the chemical reaction as depicted below. Label as much as you can using the terms atom, molecule, element, compound, ionic, gas, and solid.

58. Use the following figures to identify the element or ion. Write the symbol for each, using the Zx format.

a. 11 protons, 11 electrons

b. 11 protons, 12 electrons

c. 11 protons, 10 electrons

59. Choose the statement that best answers this question: If all atoms are composed of the same subatomic particles, why do different atoms have different chemical properties?

a. The number and arrangement of the electrons matter most because the electrons of the atoms intermingle when atoms combine to form molecules.  
b. The number and arrangement of the electrons matter most because the electrons of the atoms are located in the nucleus, and the nucleus is involved in chemical reactions.  
c. The number and arrangement of the protons matter most because the protons of the atoms intermingle when atoms combine to form molecules.  
d. The number and arrangement of the protons matter most because the protons of the atoms are located in the nucleus, and the nucleus is involved in chemical reactions.

148 CHAPTER 8 CHEMICAL FOUNDATIONS: ELEMENTS, ATOMS, AND IONS



## Simulations

Students have a variety of ways to apply their problem-solving skills with practice problems, group discussion activities, and online practice in the MindTap platform.

### APPLICATION OF HESS'S LAW

Investigate how the enthalpies of a series of reactions can be added together according to Hess's law. Determine the enthalpy for the formation of tin(II) bromide and titanium tetrachloride from tin(II) chloride and titanium(II) bromide.

**Team Learning Worksheet** questions are designed for students to work in groups to explain their reasoning for answers and solutions. These require discussion and a true depth of understanding to explain and provide details and examples to support claims.

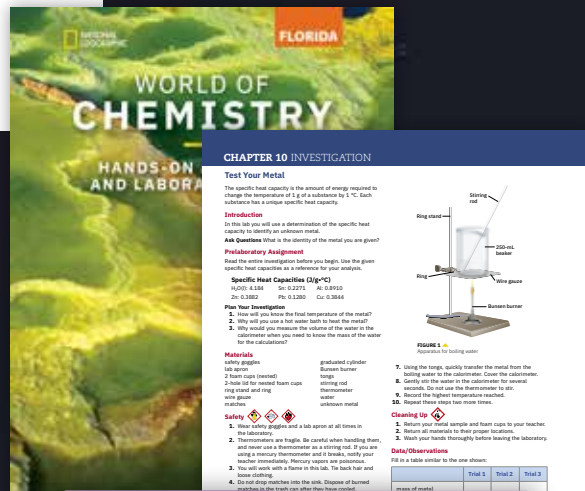
The eBook content is enhanced with embedded videos, simulations, and 3D molecular model viewers as well as highlighting and note-taking tools.

Built for the students and educators of Florida. With 100% coverage of the NGSSS (Next Generation Sunshine State Standards for Science), all students will be equipped for success.



# HANDS-ON CHEMISTRY AND ENGINEERING PROJECTS

Shifts in science teaching mean more active student learning through Science and Engineering Practices. *World of Chemistry* offers a wide range of activities, labs, projects, and investigations to keep students applying chemistry knowledge and building hands-on problem-solving skills.



Student materials include chapter Minilabs, a full Investigation lab for each chapter, and four large scale engineering projects in the Activity Guide.

## Hands-on Chemistry Minilab

### The Nuts and Bolts of Stoichiometry

#### Materials

cup of nuts and bolts

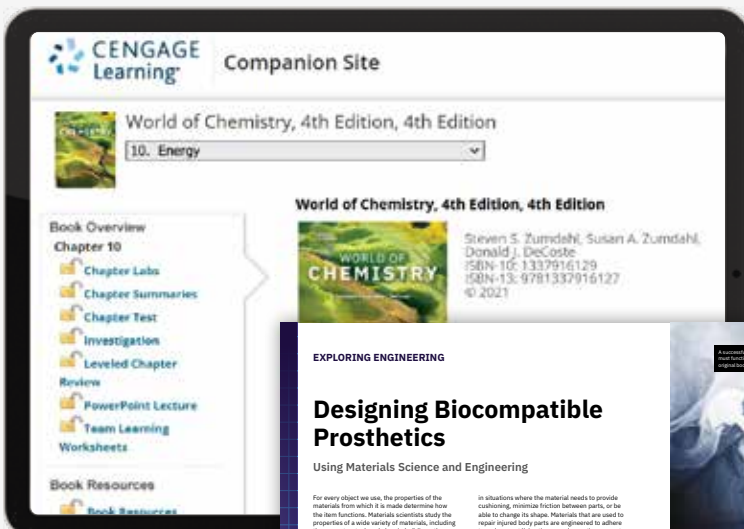
#### Procedure

1. Obtain a cup of nuts and bolts from your teacher.
2. The nuts and bolts are the reactants. The product consists of two nuts on each bolt. Make as many products as possible.

#### Results/Analysis

1. **Analyze** Using N to symbolize a nut and B to symbolize a bolt, write an equation for the formation of the product. Pay attention to the difference between a subscript and a coefficient.
2. **Count** How many nuts did you have? How many bolts?
3. **Count** How many products could you make?

4. **Evaluate** Which reactant (nut or bolt) was limiting? How did you make this determination?
5. **Evaluate** Was the limiting reactant the one that originally had fewer or more pieces?
6. **Predict** The average mass of a bolt is 10.64 g, and the average mass of a nut is 4.35 g. Suppose you are given "about 1500 g" of bolts and "about 1500 g" of nuts. Answer the following questions:
  - a. How many bolts are in "about 1500 g"? How many nuts are in "about 1500 g"?
  - b. Which reactant is limiting? Why is there a limiting reactant, given that you have equal masses of each?
  - c. Was the limiting reactant the one that had fewer or more pieces? Compare this answer to your answer in question 5. What does it tell you?
  - d. What is the largest possible mass of product? How many products could you make?
  - e. What is the mass of the leftover reactant?



Additional hands-on labs and projects are available for download from the teacher **Companion Site** including Chapter Labs, Classroom Activities and Projects, and the Team Learning Worksheet activities.

## EXPLORING ENGINEERING

### Designing Biocompatible Prosthetics

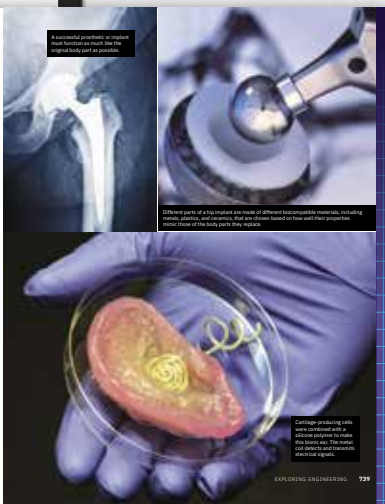
Using Materials Science and Engineering

For every object we use, the properties of the materials from which it is made determine how the item functions. Materials scientists study the properties of a wide variety of materials, including the concrete, steel, and glass in buildings, the metals in vehicles, the numerous materials in microscopes and electronic devices, and the many different kinds of plastics found in the modern world. Materials engineers assess the properties that a material should have in order to perform a specific function. They also test different materials' abilities to hold these criteria. Materials scientists and engineers use chemistry to develop novel materials based on their desired properties. The modern field of biomaterials engineering

in situations where the material needs to provide cushioning, minimize friction between parts, or be able to change its shape. Materials that are used to repair injured body parts are engineered to adhere to and support living tissue, and sometimes even to distinguish as the surrounding tissue heals. More recent advances in biomaterials engineering apply the technology of 3D printing with combinations of biological and synthetic materials to design implants that mimic the structure and behavior of components such as muscle, cartilage, bone, and organ tissue at a cellular level. These materials are often better tolerated by the immune system than traditional implant materials. Additionally, the resulting tissue can

be a body, and be used to make use of the "real" for these applications. Chemical stability, if features of which an implant and define replacement for this application, trade-offs in determining the processes they use to remove phosphorus. Some plants use just one method. Others use both, often with precipitation used as a backup to the bacterial method.

**FIGURE 6-6** Aerial view of a water treatment plant that removes phosphorus from wastewater.



## Chemical Engineering

### Treating Wastewater

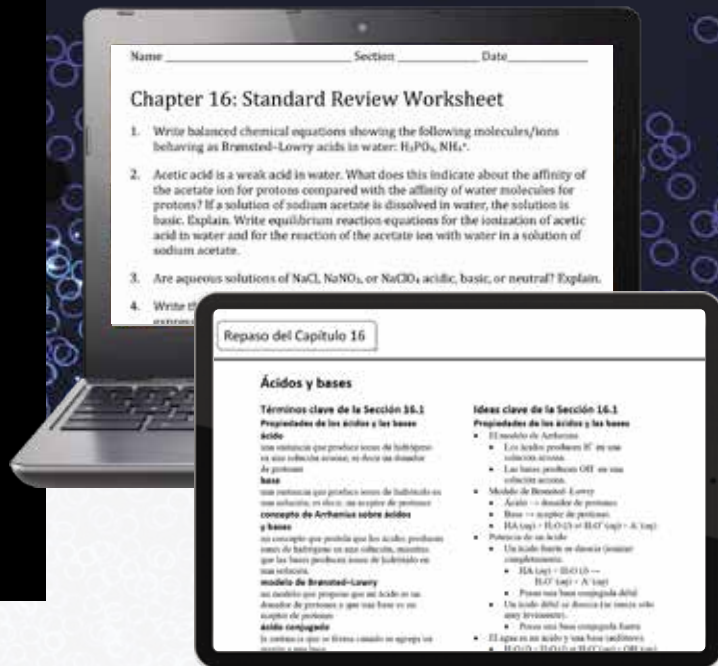
Excess phosphorus in water can disrupt freshwater ecosystems. Phosphorus is a nutrient for algae. An excess of phosphorus can cause high concentrations of algae to form. This can kill fish and other aquatic life. Wastewater contains significant amounts of phosphorus, often in the form of phosphate ions. We have recently greatly reduced the amount of phosphates we use in detergents and personal care products. However, a significant amount of phosphorus still exists in wastewater because it is present in human and animal waste. Many wastewater treatment plants have processes to remove phosphorus from wastewater before releasing the water back into the environment. Two main methods are used for removing phosphates from

wastewater. One method is to add chemicals that precipitate the phosphates out of solution. The precipitate can be removed using physical methods such as filtration. Another method for removing phosphates is to use bacteria. Some types of bacteria use phosphorus as a nutrient. These bacteria store the phosphates in their cells. As bacteria consume the nutrients in the wastewater, the amount of phosphorus in the water decreases. The bacteria are then removed from the water. Removing phosphorus by precipitation is often easier than using bacteria. It can give more reliable results. It also requires less equipment. However, the added chemicals can be expensive. If a lot of precipitate forms, it may be more difficult to dispose of the resulting product. Wastewater plants consider these and other



# CONNECT ALL STUDENTS IN QUALITY LEARNING

Students will enter chemistry classes with a wide variety of skills and experience, the need for teacher support to meet these needs is critical. *World of Chemistry* includes everything teachers need to ensure all students can access materials, activities, and digital resources for mastering chemistry.



**MEETING INDIVIDUAL NEEDS**  
**Reading Concepts**

It may have been some time since students dealt with chemical equations. For a review, have students read the *Reading Chemical Equations* resource located on the Instructor Companion Website.

**DIFFERENTIATED INSTRUCTION**  
**Leveled Support**

<p><b>Advanced Learners</b></p> <p>In this section, students learn that entropy is a measure of the dispersal of energy. Have advanced students explore the concept that the natural tendency of the universe is for energy to become more spread out by having them do research to find real world implications of the second law of thermodynamics.</p>	<p><b>Struggling Students</b></p> <p>If students have difficulty understanding the concept of entropy, show them Figure 10-26. Emphasize that steam has less order and therefore a higher value of entropy than ice. Then have them look at Figure 2-10 in <b>Chapter 2</b>. Point out the diagrams for ice and water. Ask them which seems to have less order and therefore a higher value of entropy.</p>
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**DIFFERENTIATED INSTRUCTION**  
**English Language Learners**

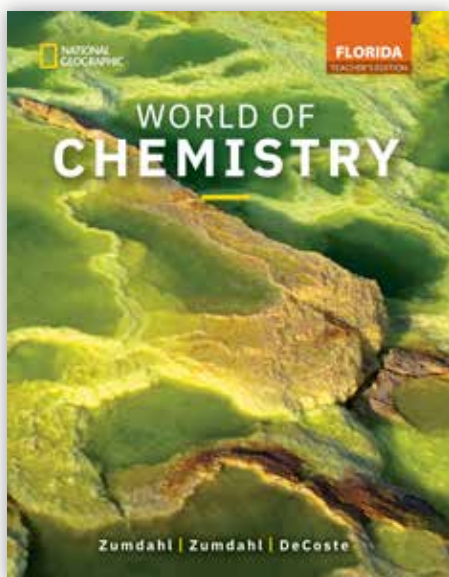
**Use Academic Language** Some phrases in this section may sound unusual to students or may be difficult to translate if the literal meanings of the words are used. Ask students what they think the literal translations of “giving up an electron” and “lose an electron” are. Then explain that both phrases refer to the release of an electron from an atom, often during a chemical reaction. Also ask students to describe the literal meaning of “chemically active,” and then explain that it refers to an element that has a structure that enables it to readily participate in a chemical reaction. To check students’ understanding, have them write sentences using all three phrases correctly.

Support diverse learners with Differentiated Instruction boxes to provide leveled support for Struggling Students, Advanced Learners, and English Learners. Meeting Individual Needs notes provide strategies for addressing math concepts and reading skills in the context of chemistry.



# COURSE SUPPORT AND TEACHING TOOLS

Additional downloadable resources include lecture slides, chapter tests, student practice pages, chapter summaries in English and Spanish, and the Cognero customizable test generator.



The wraparound Teacher's Edition includes Chapter Planning Guides summarizing chapter resources including support for differentiation, hands-on lessons, interdisciplinary and career connections, MindTap online learning resources.

**Crosscutting Concepts Boxes** help teachers deepen students' understanding and connect with prior learning. Each **Scientific Practices** or **Engineering Practices** box supports the use of the chemistry content to engage students in these practices. **Connect to ELA** features provide strategies for addressing Florida's B.E.S.T. Standards for Math and ELA.

## SCIENTIFIC PRACTICES Developing and Using Models

Use two simple ball-and-stick models of the same molecule (water is a good example) to make your discussion of percent composition more concrete. Show students one model and ask them how to determine the percent by mass of each of the different colored balls in the model. The model can be taken apart to illustrate both models and ask students to determine the percent by mass in a sample consisting of two models. Give students time to calculate this answer if they do not recognize that the percent composition must be the same for a sample containing one model as it is for the sample containing two models. Use sample size composition.

## CONNECT TO MATHEMATICS Reason Quantitatively and Use Units to Solve Problems

When working through an example on their own, students will need to refer to the periodic table to find relative atomic masses for given elements. Note to students that the relative atomic mass has no units because it is a ratio. To further illustrate the relationship between relative atomic mass and average atomic mass, ask students to choose an element that has a relative atomic mass on the periodic table and calculate how to calculate

For example, the relative atomic mass of iron on the periodic table is

$$55.85 = \left( \frac{\text{average atomic mass of Fe in amu}}{1 \text{ amu}} \right),$$

so the average atomic mass for Fe is 55.85 amu. Converting to grams,

$$55.85 \text{ amu} \left( \frac{1.66 \times 10^{-24} \text{ g}}{1 \text{ amu}} \right) = 9.27 \times 10^{-23} \text{ g}.$$

## CROSSCUTTING CONCEPTS Scale, Proportion and Quantity

Due to rapid technological advances over recent decades, scientists can now directly observe individual atoms. However, many experimental techniques use indirect measurements to make inferences about atomic or subatomic phenomena. For example, a mass spectrometer ionizes atoms in a sample and deflects them using magnetic fields to determine their masses. Encourage students to consider how much they are deflected. In contrast, some subjects, such as global populations of organisms, are too large or widespread to observe directly. These measurements must be made over smaller, more feasible regions and extrapolated using assumptions to estimate their actual values. Encourage students to consider the spatial and time scales of each scientific phenomenon they study, and under what conditions direct or indirect measurements can be made.

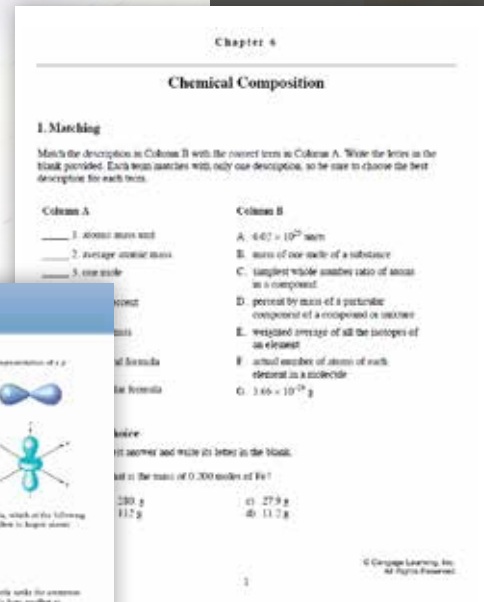
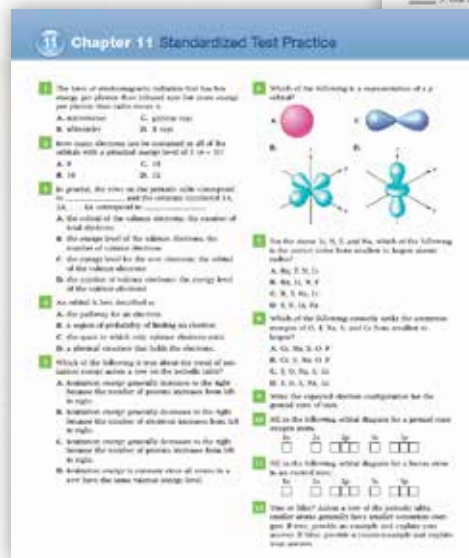
## CONNECT TO ELA Text Types and Purposes

Have students write an explanation of how to find the number of moles of each element in one mole of a given compound, using an analogy outside of chemistry to support their explanation. (For example, one car has four tires, so a mole of cars has four moles of tires.)



# ASSESSMENTS IN A VARIETY OF FORMATS

In addition to “checkpoint” questions throughout the student book and chapter review questions, a variety of supplementary assessment materials allow teachers to customize the approach to ensuring student success. Each chapter includes a Standardized Test Practice assessment, a comprehensive Chapter Test, and supplementary student worksheets and activities.



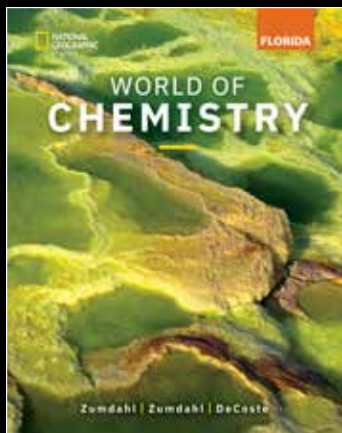
Cognero Test Bank is a flexible, online system that allows you to author, edit, and manage test content.



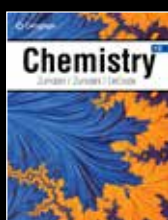
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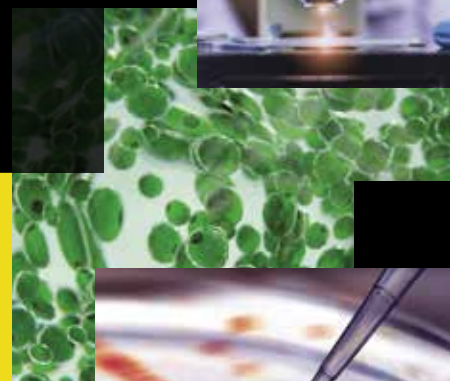


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