

World of Chemistry

Zumdahl / Zumdahl / DeCoste

World of Chemistry is designed to be accessible to all students with:

- Approachable writing and narrative style
- National Geographic Explorers and images
- Detailed problem-solving support
- Engineering design
- Real-world applications

National Geographic Explorers and visuals capture student attention and tell the story of how chemistry is critical to daily life. *World of Chemistry* includes the OWLv2 online learning platform and aligns to the Next Generation Science Standards (NGSS).

World of Chemistry

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Authentic Student Engagement

Engage students with National Geographic images and stories of National Geographic Explorers who use chemistry to solve real-world problems. “Case Studies” and “Chemistry in Your World” features highlight real-world applications of chemistry.

CHAPTER 20 ORGANIC CHEMISTRY

Did you know that nearly all of the plastic-based materials you use come from the same sources as gasoline, natural gas, and other fuels? Petroleum-based polymers—plastics derived from fossil fuel resources—are everywhere. They are in synthetic rubbers, like those used to make an inflatable kayak. They are used to produce carbon fiber composites for making boat paddles. The nylon used to make a winter coat, the polyester filling used to line it, and the polyvinyl chloride (PVC) used to make waterproof footwear are all examples of polymers developed...

EXPLORERS AT WORK

Investigating Marine Microplastics
with National Geographic Explorer Imogen Napper

National Geographic Explorer Imogen Napper has always been passionate about the ocean. Growing up in the coastal city of Bristol, England, she developed a love of sea life at an early age. As a teenager, her father and sailing instructor encouraged her contribution to protecting the ocean's health. She began collecting in beach areas across the world.

It was during these outings that she first became aware of the problem of microplastics in the ocean. The pieces of plastic waste that accumulate in beaches and on the seabed, known as microplastics, are a growing environmental concern. They are often ingested by sea life and can be harmful. As these particles break down, they release harmful substances. The particles may also absorb and transport other toxic substances from the water along with them. Napper decided to study the effects of microplastics on the seabed for degrees in marine science.

These days, a large percentage of clothing is made from plastic fibers. More than 100 million pounds of these synthetic fibers are made from synthetic materials such as polyethylene, nylon, and acrylic. Each year, an estimated 100 million pounds of synthetic fibers are being used because they are lightweight, durable, and easy to clean.

But unlike these soft, synthetic fibers, these fibers are not biodegradable. When they are in the ocean, they can be ingested by sea life. In fact, they are found in the stomachs of many marine animals. This is why it is so important to reduce the amount of synthetic fibers that end up in the ocean.

Napper used her research to complete her Ph.D. in marine science. Her work continues to help solve the global problem of microplastics. Napper received an NSF grant to support a year in conducting research on marine microplastics. Her goal is to help reduce the amount of synthetic fibers that end up in the ocean.

Reducing Plastics

Reduce. Reuse. Recycle. All three steps are important to help reduce the amount of synthetic fibers that end up in the ocean. You can also help by using reusable water bottles.

National Geographic images and photography

“Explorers At Work” feature the work of National Geographic Explorers

Active Learning and Hands-on Chemistry

CHAPTER 4 INVESTIGATION

Decomposing Copper Oxide

Measure the weight of copper in the form of metallic copper, the amount of oxygen in the form of copper oxide, and the amount of oxygen in the form of copper oxide. This investigation is designed to help you understand the relationship between the mass of copper and the mass of oxygen in copper oxide. You will use the results of your investigation to determine the empirical formula of copper oxide.

Procedure

1. Weigh the test tube and the copper oxide.
2. Heat the test tube over the flame of the Bunsen burner until the copper oxide is completely decomposed.
3. Weigh the test tube and the remaining copper.
4. Calculate the mass of oxygen that was lost.
5. Calculate the mass percent of copper in the copper oxide.
6. Calculate the mass percent of oxygen in the copper oxide.

Analysis

1. Compare your results with those of your classmates.
2. Calculate the mass percent of copper in the copper oxide.
3. Calculate the mass percent of oxygen in the copper oxide.
4. Calculate the empirical formula of the copper oxide.

- Investigations are included at the end of every chapter
- “Hands-on Chemistry Minilabs” are embedded throughout each chapter
- A downloadable Lab Manual is available with additional labs aligned to the program

Hands-on Chemistry

Relative Masses

Materials

- cotton balls
- paper clips
- rubber stoppers
- balance

Procedure

1. Obtain cotton balls, paper clips, and rubber stoppers from your teacher.
2. Develop 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.

Mass of one object	Relative mass of one object	Mass of 1 object
Cotton balls	g	lb
Paper clips	g	lb
Rubber stoppers	g	lb

Analysis

1. Compare the lightest object's relative mass of 1.0 to 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 x .
3. Calculate if you had x of each of the other objects, how much would each sample weigh? Fill in the numbers into your table.
4. Analyze Determine which columns correspond to the chemical terms “atomic mass” and “molar mass.”
5. Interpret Which number represents “Avogadro’s number?”

- An “NGSS Activity Guide” includes hands-on, 3-Dimensional learning
- The Teacher’s Edition includes many additional classroom activities and demonstrations.

Engineering Practices and Design

Designing Biocompatible Prosthetics

using Materials Science and Engineering

As every object has its own design, the design of the prosthetic must reflect its function. Materials scientists study the properties of a wide variety of materials, including the chemical, physical, and mechanical properties of metals, polymers, and composites. They use this information to design materials that are suitable for use in prosthetics. The design of a prosthetic must take into account the mechanical and chemical properties of the materials used. The design of a prosthetic must also take into account the biological properties of the materials used. The design of a prosthetic must also take into account the manufacturing process used to create the prosthetic.

Chemical Engineering

Treating Wastewater

Excess phosphorus in water can do just what you don't want: it can cause algae to grow. 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 phosphorus 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 phosphorus from wastewater. One method is to add chemicals that precipitate the phosphorus out of solution. The precipitate can be removed using physical methods such as filtration. Another method for removing phosphorus is to use bacteria. Some types of bacteria use phosphorus as a nutrient. These bacteria store the phosphorus 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 trade-offs in determining the processes they use to remove phosphorus. Some use just one method. Other plants use both, often with precipitation used as a back-up to the bacterial method.

The work of Engineers is highlighted in “Exploring Engineering” articles at the beginning of some chapters and in “Chemical Engineering” features throughout the program. The Engineering Practices from the NGSS are detailed in Chapter 1 and are applied by students in hands-on labs and Investigations.

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Teacher Support

SECTION 6.2

Molar Mass and Percent Composition

EXPLORE/PLAN

In this section, students move from calculating amounts of elemental substances based on atomic mass units to calculating a compound's molar mass based on its chemical formula. Students then apply this reasoning to convert between mass and moles, leading to multi-step calculations to determine percent composition.

Active Learning

The Section 6.2 Team Learning Worksheet on the Instructor Companion Website provides opportunities for students to work collaboratively.

Molar Mass

One Mass and Skills

- EXPLAIN the concept of molar mass.
- CONVERT between moles and mass.

Teaching Tip

- Some students find it difficult to translate a formula into moles at this point. For example, 1 mole of methane molecules contains 4 moles of hydrogen atoms. Make sure students practice this translation and justify their answers.
- Emphasize that molar mass is the mass per one mole of substance. For example, 1 mole of atomic oxygen gas has a mass of 16.00 g. A molecule containing 2 moles of oxygen gas has a mass of 64.00 g.
- The term molar mass has replaced molecular weight because molar mass more accurately describes the concept.
- Students sometimes are confused about which number from the periodic table to use to find molar mass. Remind students that atomic masses are used, not atomic numbers.

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.)

CONNECT TO MATHEMATICS Model with Mathematics

Introduce a binary compound of the form A_xB_y , containing unknown elements A and B with molar masses M_A and M_B , respectively. Ask students to write a mathematical formula to calculate the molar mass of this compound. Refer them to Example 6.5 to use as a guide if they have difficulty. Answer: Molar mass of $A_xB_y = xM_A + yM_B$

EXAMPLE 6.5

Calculate the molar mass of $CaCl_2$. The molar mass of Ca is 40.08 g/mol and the molar mass of Cl is 35.45 g/mol.

Solution

1 mole of $CaCl_2$ = 1 mole of Ca + 2 moles of Cl

1 mole of $CaCl_2$ = 40.08 g + 2(35.45 g)

1 mole of $CaCl_2$ = 111.0 g

The molar mass of $CaCl_2$ is 111.0 g/mol.

Check Your Work

The molar mass of $CaCl_2$ is 111.0 g/mol. The molar mass of Ca is 40.08 g/mol and the molar mass of Cl is 35.45 g/mol. The molar mass of $CaCl_2$ is 111.0 g/mol.

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The wraparound Teacher’s Edition includes Chapter Planning Guides summarizing chapter resources including support for differentiation, hands-on lessons, interdisciplinary and career connections, OWLv2 online learning resources, and NGSS support.

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

OWLv2 For World of Chemistry

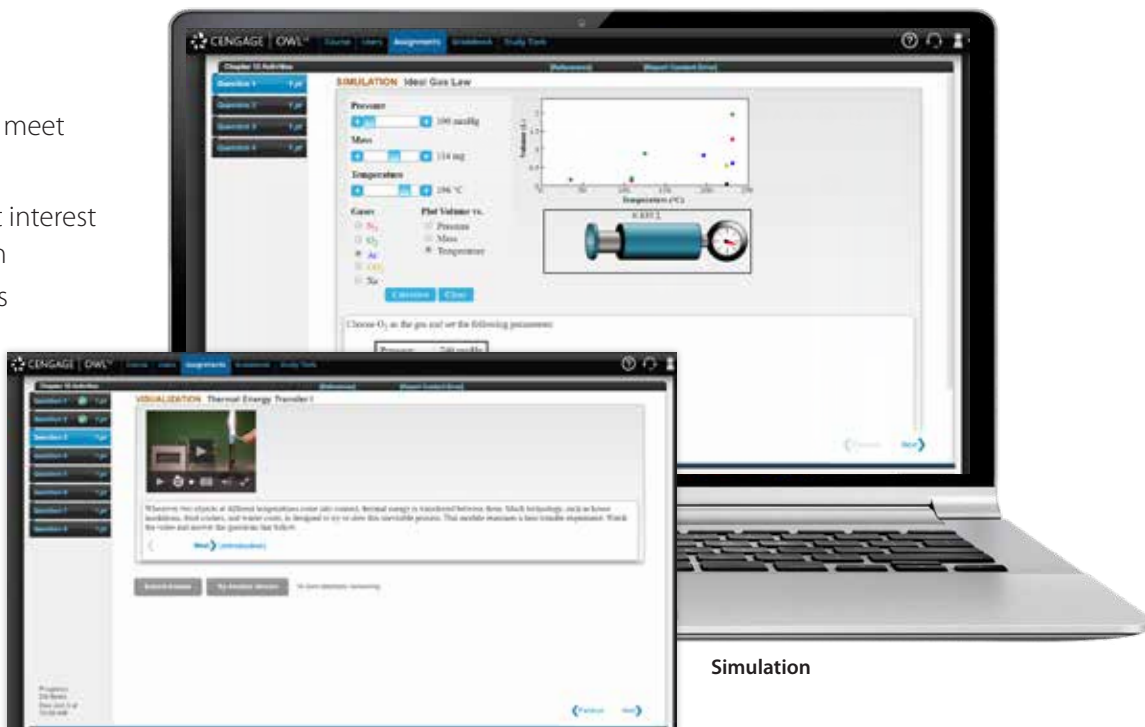
Move students beyond memorization of concepts to higher level chemistry thinking with OWLv2. This powerful platform empowers students to learn chemistry through rich, dynamic problems, detailed feedback, and interactive learning modules. With OWLv2, students practice at their own pace, receive meaningful feedback, and access learning resources to help them achieve better grades.



Engaging Practice Problems

OWLv2 offers learning tools to meet students on their level.

- Simulations capture student interest with virtual experimentation
- Visualizations provide videos or animations with questions to improve understanding of cause-and-effect and improve observational skills
- Tutorials help students develop problem-solving skills by offering a step-by-step explanation of how to work through a problem.



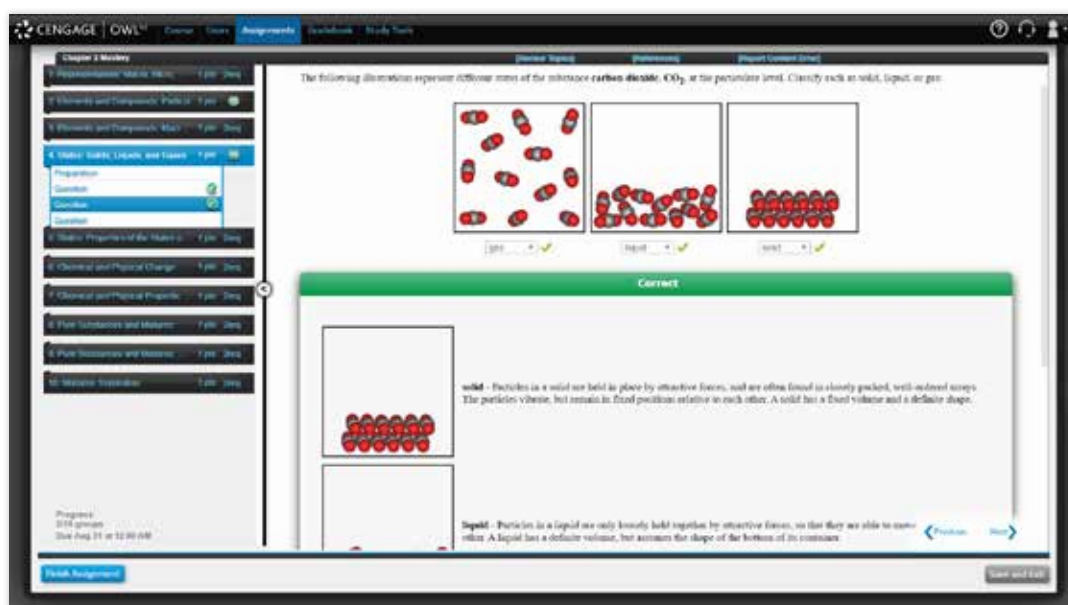
Visualization

Simulation

Mastery Learning

Mastery Learning assignments allow students to practice at their own pace, receive meaningful feedback, and use included learning resources to master chemistry concepts.

Students must answer two or more questions in a group correctly to prove true mastery. OWLv2 gives hints and feedback along with the complete solution. When students retry a group of questions, the values and chemicals change, to allow continual practice and a deeper understanding of the concepts.



Powerful Gradebook and Analytics

Keep a continuous pulse on student progress with the easy-to-use gradebook and powerful analytics reports in OWLv2. The gradebook lets teachers see how students are doing with both comprehensive reports and concise progress snapshots.



Interactive eBook

The eBook available in OWLv2 includes the entire text with enhanced digital capabilities. These include embedded videos, simulations, and 3D molecules for students to manipulate in support of the text.

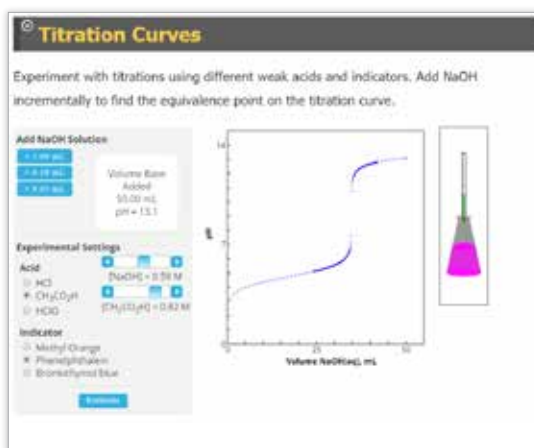
Other eBook features include highlighting and notetaking, clickable vocabulary with pop-up definitions, a ReadSpeaker feature which reads the text aloud, and digital flashcards for each chapter. Students can even create their own flashcards.



eBook text



Embedded eBook Videos



Embedded eBook Simulations



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ISBN-13: 978-03572-37533
ISBN-10: 03572-37536



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