Chemistry in the Community, 6th Edition

Not Your Typical Chemistry Textbook

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UNIT 3

PETROLEUM: BREAKING AND MAKING BONDS

How can the physical properties of petroleum be explained by its molecules and their interactions?

SECTION A
Petroleum—What is it? (page 266)

Why are carbon-based molecules so versatile as chemical building blocks?

SECTION B
Petroleum: A Building-Material Source (page 297)

What are the benefits and consequences of burning hydrocarbons?

SECTION C
Petroleum: An Energy Source (page 303)

What alternatives to petroleum are available for burning and building?

SECTION D
Alternatives to Petroleum (page 358)

Interest is growing in alternative-energy-powered transportation. Why? What advantages and disadvantages do petroleum alternatives offer? How can the global supply of petroleum best be used? How can knowledge of chemical bonds help consumers make informed decisions about petroleum use? Turn the page to learn more about this energy-rich resource.

The unit opener showcases the questions that drive each section and provides a quick reference to the section titles and locations.

The “teaser” question box introduces an issue that ties chemistry to daily life and previews the unit challenge.

Unit Structure
Each unit begins with a challenge, which introduces students to a real-world scenario. By the end of the unit, students will need to make an informed decision related to the scenario. This requires chemistry knowledge and scientific inquiry, providing a “need-to-know” that sets the stage for the unit.

Are the claims made in this advertisement for the new TLC-p accurate? Is it truly a “transformative” vehicle? Will it help reduce owners’ reliance on petroleum and other carbon-based fuels? Do better transportation options exist? Could you produce an advertisement for a “greener” automobile?

To answer these questions, you will learn about petroleum and how it fuels our modern lives. You’ll consider the challenges of providing energy and building materials to an ever-increasing population, while protecting the planet we all share.

At the end of the unit, you will be challenged to create your own video advertisement for an alternative-fuel vehicle. Your ad will reflect what you have learned and make evidence-based claims, while revealing your vision for the future of automobile transportation.

Developing a vision of the future requires knowing something about the past, the present, and the possibilities. As you create your commercial message, you will learn about the origin and structure of the hydrocarbon compounds presently used to power most automobiles and why the molecules of these compounds are so useful as fuels and raw materials for the manufacture of important products. You will explore the consequences of using hydrocarbon fuels and investigate alternative sources of energy and matter. As you move toward understanding the role of petroleum, keep in mind the impact of decision-making at the personal, community, and global levels.
Putting it All Together

GETTING MOBILE

If you are an average U.S. high school student, you have already viewed about a half-million television commercials, many of them for automobiles. As alternative-fuel vehicles become more available, advertisements similar to the one that opened this unit will become more common.

To make informed, intelligent consumer decisions, it is important to analyze the information conveyed in such advertisements, much as you did when you investigated claims in Unit 2. You can further develop your analytical skills by devising and defending your own product claims.

You will now draft and produce your own automobile advertising message. After presenting your commercial message, you will answer questions posed by other students.

LOOKING BACK AND LOOKING AHEAD

This unit has illustrated once again that chemical knowledge can help inform personal and community decisions related to resource use and possible replacement options. Thus far in your ChemCom studies, you have focused on three types of resources: air, minerals, and petroleum. The next unit explores another kind of resource—water—the most abundant substance on Earth. As you will learn, use of water and responsibility for providing and maintaining clean water are important, and sometimes contentious, issues in every community.

Each unit ends with a summative piece called Putting It All Together, which relates to the unit challenge. Once students complete the unit, PIAT can act as a summative assessment of content and context covered in the unit.
Section Features

- **Opening Question**
- **Goals**
- **Concept Check**
- **Chem Quandry**
- **Five Section Types**
  - “Traditional” B.2
  - Investigating Matter A.5
  - Modeling Matter A.12
  - Developing Skills B.3
  - Making Decisions B.12
- **Section Summary** (pg. 294)
  - Reviewing the Concepts
  - Opening question
  - Connecting the Concepts
  - Extending the Concepts
Teacher Resources

- Teacher’s Edition
- Teacher Resource Materials (TRMs)
- Test Bank
- Lab Videos
- PowerPoints
- NGSS alignment

Test bank, videos, and PPTs are in the Dropbox folder.
NGSS alignment

  - Sixth edition published 2012
- Frameworks published 2012
- NGSS published 2013
- Folder with all NGSS information is available here
  - General NGSS document
  - Extensive SEP alignment (NGSS inventory files)
  - ESS PE alignment
How to order

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  - Hardback Vol 1 (Units 0-4) $100/unit
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Thank you!

If you have any questions, please don’t hesitate to follow up:

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Thousands of people use chemistry every day. The Chemistry at Work Q&A section introduces students to some working chemists. In the interview, the chemists convey how they apply chemical processes and principles in their careers.
Key Features

Each section opens with a section question that stimulates and guides student learning within the section. These are the questions from the opening page of the Unit, and are revisited at the end of the section.

Learning goals are provided at the start of each section to highlight key skills and ideas that students should know, understand, or be able to do by the end of the section. These goals are also revisited at the end of each section.

GOALS

- Describe the chemical makeup of petroleum and how it is refined.
- Describe the use of distillation as a separation technique and the application of fractional distillation to petroleum refining.
- Identify and write formulas for alkanes.
- Define isomer and draw structural formulas for possible isomers of a particular hydrocarbon.
- Predict and explain relative boiling points of hydrocarbons in terms of their intermolecular forces.
Key Features

Concept Checks require students to activate prior knowledge – either from the course or from real life. This is a good TPS activity, or a quick homework assignment. Usually one question addresses a topic students are about to encounter.

**concept check 1**

1. List three classes of this unit.
2. Name some or distinguish.
3. Petroleum is up hydrocarbons.
4. List some other names petroleum.

**concept check 2**

1. Where did petroleum's energy originate?
2. How are the components of petroleum
   a. similar to one another?
   b. different from one another?
3. For a given component of petroleum, how does the number of carbon atoms within its molecules relate to its viscosity and boiling point?
A ChemQuandary is a chemistry-related question or situation that stimulates thinking and decision-making. It often results in more questions than answers and rarely has a single "correct" answer. It can be used as a TPS, to begin a discussion, or as a prompt for a journal entry.

**ChemQuandary**

**FUELS AND CLIMATE**

Different parts of the United States experience very different climates. Automobile fuel used in Maine during its cold winter months differs from fuel used, say, in Arizona during hot summer months (Figure 3.23).

- Why do differing climates require different automobile fuels? What practical reasons are there (in terms of transport, storage, and transfer of fuel) for tailoring fuel to a specific climate?
- What aspects of the components of fuel used in a Maine winter would differ from the components of fuel used during a summer in Arizona? (*Hint:* Think in terms of molecular structure.)

*Figure 3.23 How would the properties of the gasoline being pumped in these two situations vary?*
There are few sections that aren’t labeled with an activity type. This is where you’ll find more traditional textbook content.

**B.2 CHEMICAL BONDING**

Hydrocarbons and their derivatives, including the polymers you investigated in Making Decisions B.1, are the focus of the branch of chemistry known as **organic chemistry**. These substances are called **organic compounds** because early chemists thought that living organisms—plants or animals—were needed to produce them. However, chemists have known for more than 150 years how to make most organic compounds without any assistance from living systems.

In hydrocarbon molecules, carbon atoms are joined to form a backbone called a **carbon chain**. Hydrogen atoms are attached to the carbon chain. Carbon’s versatility in forming bonds helps explain the abundance of different hydrocarbon compounds. To illustrate this versatility, recall the large number of alkanes that could be made from six carbons in Modeling Matter A.12 (page 290). Hydrocarbons can be regarded as the starting point of an even larger number of compounds that contain atoms of other elements attached to a carbon chain.

Before learning more about hydrocarbon compounds, it will be helpful to understand how atoms are joined together to form molecules through chemical bonding. You probably already learned in other science courses that electrons are involved in chemical bonding. In Unit 1, you learned about chemical bonds that are formed when atoms gain or lose electrons—ionic bonds. Electrons are also central to bonding in hydrocarbons, so let us begin our study of chemical bonds by considering the role of electrons.
Key Features

Investigating Matter activities are labs; they require students to practice skills of scientific inquiry. All investigations follow the model of the Science Writing Heuristic.

Recent Journal of Chemical Education paper about ChemCom, SWH, and NGSS

INVESTIGATING MATTER
A.5 SEPARATION BY DISTILLATION

Preparing to Investigate

You know that you can often separate substances by taking advantage of their different physical properties. One physical property commonly used to separate liquids is their density. However, density differences will work only if substances are insoluble (do not dissolve) in each other, which is not the case with petroleum; its components are soluble (can dissolve) in each other. Another physical property chemists often use to separate substances is boiling point. The separation of liquid substances according to their differing boiling points is called distillation.

As you heat a liquid mixture containing two components, the component with the lower boiling point will vaporize first and leave the distillation flask. That component will then condense back to a liquid as it passes through a condenser—all before the second component begins to boil. See...
In Modeling Matter activities, students create and critique representations of matter, to help make connections between macroscopic observations and what happens at the molecular level.
Key Features

DEVELOPING SKILLS

B.3 PREDICTING AND REPRESENTING CHEMICAL BONDS

As in the formula for a hydrogen molecule, dots surrounding each element’s symbol represent the valence electrons for that atom. Structures such as these are called electron-dot formulas, also known as Lewis dot structures or, simply, Lewis structures. The two electrons in each covalent bond “belong” to both bonded atoms. Dots placed between the symbols of two atoms represent electrons that are shared by those atoms.

When the electrons associated with each atom are determined, each shared electron in a covalent bond is “counted” twice, once for each element. For example, count the dots surrounding each atom in methane (see above). Note that each hydrogen atom has a filled outer electron shell with two electrons. The carbon atom also has a filled outer electron shell with eight electrons. Each hydrogen atom is associated with one pair of electrons; the carbon atom has four pairs of electrons, or eight electrons.

For convenience, each pair of electrons in a covalent bond can be represented by a line drawn between the symbols of each atom. This yields another common representation of a covalently bonded substance called a structural formula.

Developing Skills sections focus on problem-solving skills using real-world situations. One or more sample problems are provided to model how to reason through, set up, and/or solve similar problems. Calculations or data are typically woven into these types of activities.

Remainder of 3B.3
Developing Skills
pg. 304
Key Features

MAKING DECISIONS

B.12 BUILDER MOLECULES IN TRANSPORTATION

You have surveyed how some petroleum components are used as building blocks for countless everyday objects. You can easily find examples of products built from petroleum-based materials in your surroundings, products that were unknown even a few decades ago. See Figure 3.39. Synthetic polymers have many advantages over traditional materials, including favorable strength-to-weight ratios and recyclability. How are these advantages of synthetic polymers useful to automobile designers when they are trying to improve the fuel efficiency of new cars? On the other hand, what are some potential downsides of the use of synthetic polymers in automobile manufacturing?

In the TV ad that opened this unit (see page 266), a new automobile was described as helping to conserve petroleum resources. Is this possible? Is it plausible? In this activity, you will consider this claim and evaluate how builder molecules are used in automobile construction.

1. List several automobile components commonly made of polymers.
2. The TV advertisement claimed that driving the TLC-p will “help conserve petroleum resources.”
Key Features

SECTION A SUMMARY

Reviewing the Concepts

The end of section questions are tiered, and model the progression found within Bloom’s Taxonomy.

Reviewing the Concepts are simple questions, and boxes within the section are linked to the learning goals at the beginning of the section.

Connecting the Concepts

Why is petroleum considered a non-renewable resource?

Using a Venn diagram, distinguish fractional distillation from simple distillation. Simple distillation is never sufficient to purate two liquids completely. Explain. A fractionating tower, petroleum virtually heated to 400 °C. What

33. The traditional unit of volume for petroleum is the barrel, which contains 42 gallons. Assume that those 42 gallons provide 21 gallons of gasoline. How many barrels of petroleum does it take to operate an automobile for one year, assuming the vehicle travels 10,000 miles and gets 27 miles per gallon of gasoline?

34. Explain why thermal energy is added at one point and removed at another point in the process of distillation.

Extending the Concepts

35. Is it likely that the composition of crude oil found in Texas is the same as that of crude oil found in Kuwait? Explain your answer.

36. Gasoline’s composition is varied by oil companies for use in different parts of the nation and for use in different seasons. What factors help determine the composition of gasoline blended for different seasons?

37. What kind of petroleum trade relationship would be expected between North America and the Middle East? If other world regions become more industrialized and global petroleum supplies decrease, how might the North America-Middle East trade relationship change?

38. How would the hydrocarbon boiling points listed in Table 3.3 (page 283) change if they were measured under increased atmospheric pressure? (Hint: Although butane is stored as a liquid inside of a tank, it escapes through the tank as a gas.)
Teacher’s Edition

- Pacing guide
- Context connections
- Supply list
- Multimedia guide **applets no longer supported
- Unit introduction
- Context and challenge
- Section question and goals tips
- Additional concept check questions
- Investigation Matter
  - Safety information
  - Preparation tips
  - Pre-lab discussion points
  - Lab tips
  - Sample data
  - Answers to questions
- Using the figures
- Additional activities
TRMs

• Handouts
  – Investigating Matter
  – Modeling Matter
  – some Making Decisions

• Supplemental activities
  – “Traditional” sections
  – Extra practice
  – Enrichment opportunities

• Reading guides for some “traditional” sections
  – Graphic organizers
  – Reading comprehension questions

• Skill Builders