

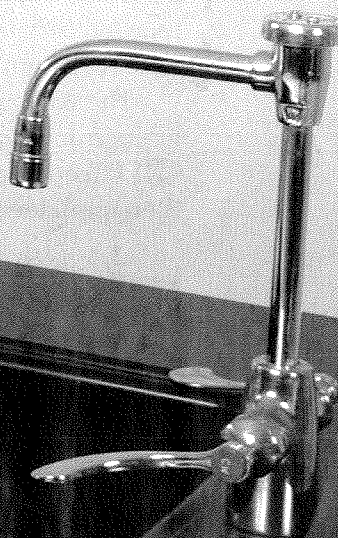
## PERIODIC TABLE OF THE ELEMENTS



After you clean up your work area, what should you do before leaving the laboratory?



Is it always appropriate to dispose of chemicals by flushing them down the sink? Explain.



# 1.4 Problem Solving in Chemistry

## Guide for Reading

### Key Concepts

- What is a general approach to solving a problem?
- What are the three steps for solving numeric problems?
- What are the two steps for solving conceptual problems?

### Reading Strategy

#### Identifying Main Idea/Details

Under the heading Solving Numeric Problems, there are three main ideas presented as subheads. As you read, list two details that support each main idea.

## Connecting to Your World

Shape-sorter toys fascinate young children. Typically, the children try placing a shape in different holes until they find the right one. They may try to place an incorrect shape in the same hole over and over again. An older child has enough experience to place the correct shape in each hole on the first try. The trial-and-error approach used by young children is one method of problem solving, but it is usually not the best one. In this section, you will learn effective ways to solve problems in chemistry.



## Skills Used in Solving Problems

Problem solving is a skill you use all the time. You are in a supermarket. Do you buy a name brand or the store brand of peanut butter? Do you buy the 1-liter bottle or the 2-liter bottle of a carbonated beverage? Do you choose the express line if there are five customers ahead of you or the non-express line with a single shopper who has lots of items?

When you solve a problem you may have a data table, a graph, or another type of visual to refer to. The shopper in Figure 1.23 is reading the label on a can while trying to decide whether to buy the item. She may need to avoid certain ingredients because of a food allergy. Or she may want to know the amount of Calories per serving.

The skills you use to solve a word problem in chemistry are not that different from those you use while shopping or cooking or planning a party.

**Effective problem solving always involves developing a plan and then implementing that plan.**

**Figure 1.23** A shopper must make many decisions. Some of those decisions are based on data, like the information on a food label.



## Solving Numeric Problems

Because measurement is such an important part of chemistry, most word problems in chemistry require some math. The techniques used in this book to solve numeric problems are conveniently organized into a three-step, problem-solving approach. This approach has been shown to be very helpful and effective. So we recommend that you follow this approach when working on numeric problems in this textbook. 🗣️ **The steps for solving a numeric word problem are analyze, calculate, and evaluate.** Figure 1.24 summarizes the three-step process and Sample Problem 1.1 shows how the steps work in a problem.

① **Analyze** To solve a word problem, you must first determine where you are starting from (identify what is known) and where you are going (identify the unknown). What is known may be a measurement. Or it may be an equation that shows a relationship between measurements. If you expect the answer (the unknown) to be a number, you need to determine what units the answer should have before you do any calculations.

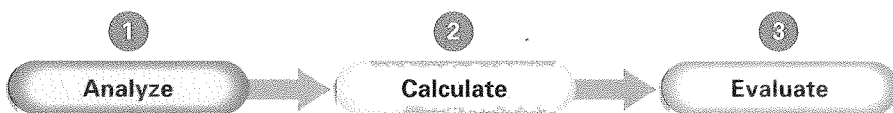
After you identify the known and the unknown, you need to make a plan for getting from the known to the unknown. Planning is at the heart of successful problem solving. As part of planning, you might draw a diagram that helps you visualize a relationship between the known and the unknown. You might need to use a table or graph to identify data or to identify a relationship between a known quantity and the unknown. You may need to select an equation that you can use to calculate the unknown.

② **Calculate** If you make an effective plan, doing the calculations is usually the easiest part of the process. For some problems, you will have to convert a measurement from one unit to another. Or you may need to rearrange an equation before you can solve for an unknown. However, you will be taught these math skills as needed. There will also be reminders throughout the textbook to use the Math Handbook in Appendix C.

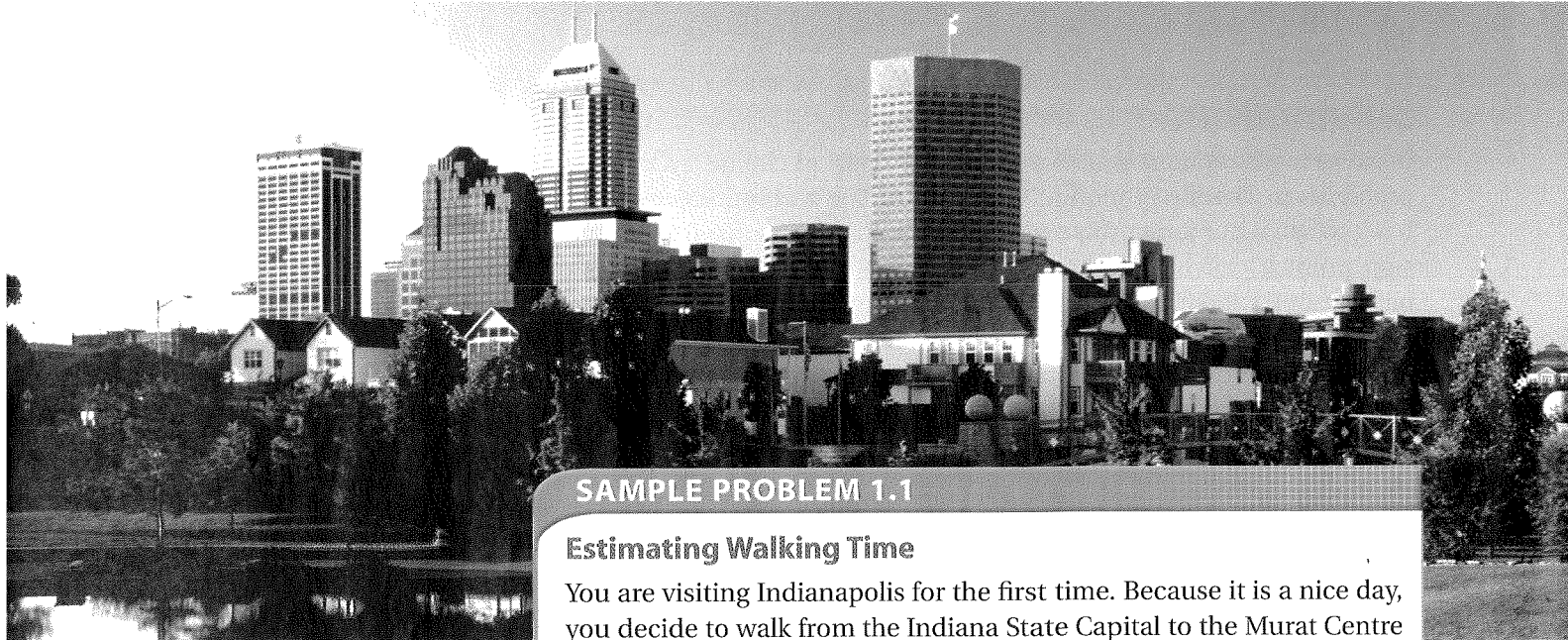
③ **Evaluate** After you calculate an answer, you should evaluate it. Is the answer reasonable? Does it make sense? If not, reread the word problem. Did you copy the data correctly? Did you choose the right equations? It helps to round off the numbers and make an estimate of the answer. If the answer is much larger or much smaller than your estimate, check your calculations.

Check that your answer has the correct unit and the correct number of significant figures. You may need to use scientific notation in your answer. You will study significant figures and scientific notation in Chapter 3.

✓ **Checkpoint** *How can making an estimate help you evaluate an answer?*



**Figure 1.24** This flowchart summarizes the steps for solving a numeric problem. **Predicting** *In which step do you make a plan for getting from what is known to what is unknown?*



This view of Indianapolis, Indiana, shows part of the historic central canal in White River State Park.

### SAMPLE PROBLEM 1.1

#### Estimating Walking Time

You are visiting Indianapolis for the first time. Because it is a nice day, you decide to walk from the Indiana State Capital to the Murat Centre for an afternoon performance. According to the map in Figure 1.25, the shortest route from the capital to the theater is 8 blocks. How many minutes will the trip take if you can walk one mile in 20 minutes? Assume that 10 short city blocks equals one mile.

**1 Analyze** *List the knowns and the unknown.*

**Knowns**

- distance to be traveled = 8 blocks
- walking speed = 1 mile/20 minutes
- 1 mile = 10 blocks

**Unknown**

- time of trip = ? minutes

This problem is an example of what is typically called a conversion problem. In a conversion problem, one unit of measure (in this case, blocks) must be expressed in a different unit (in this case, minutes).

Divide the distance to be traveled (in blocks) by the number of blocks in one mile to get the distance of the trip in miles. Then multiply the number of miles by the time it takes to walk one mile.

**2 Calculate** *Solve for the unknown*

$$8 \text{ blocks} \times \frac{1 \text{ mile}}{10 \text{ blocks}} = 0.8 \text{ mile}$$
$$0.8 \text{ mile} \times \frac{20 \text{ minutes}}{1 \text{ mile}} = 16 \text{ minutes}$$

**3 Evaluate** *Does the result make sense?*

The answer seems reasonable, 16 minutes to walk 8 short blocks. The answer has the correct unit. The relationships used are correct.

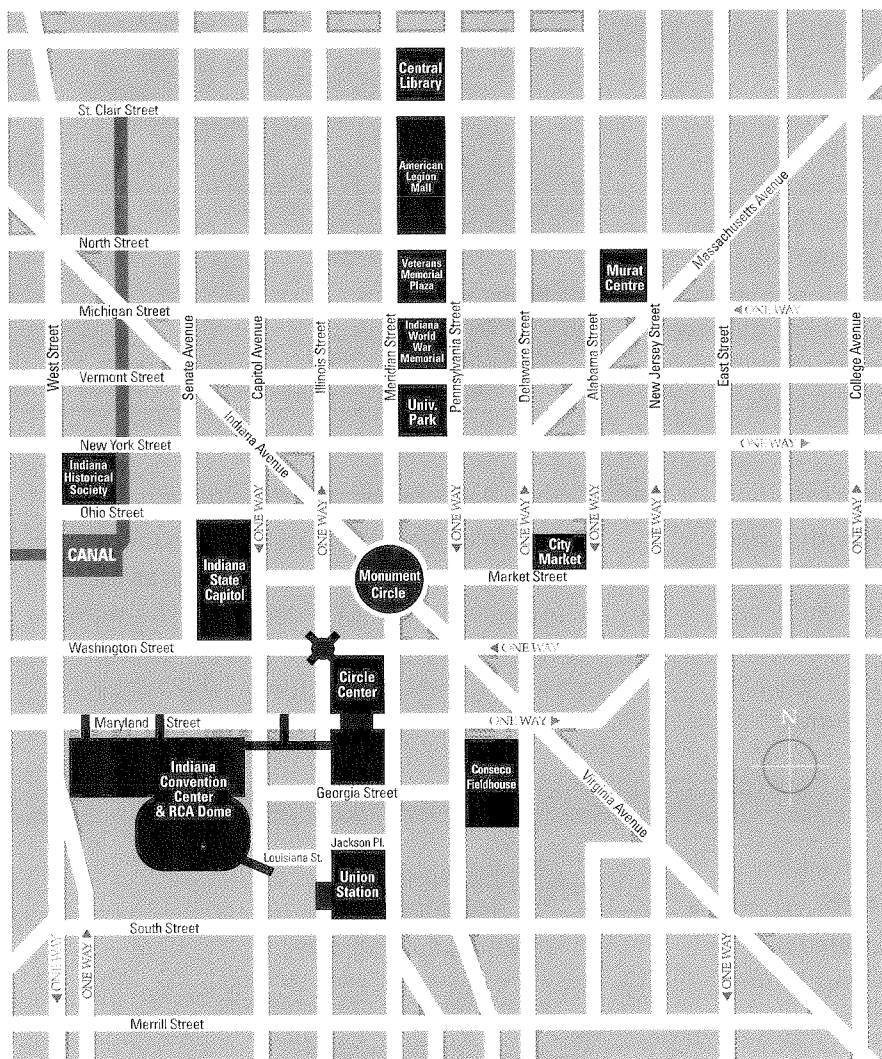
#### Practice Problems

26. Using the information in the sample problem, how many short blocks can be walked in 48 minutes?
27. There is an ice cream shop 6 blocks north of your hotel. How many minutes will it take to walk there and back?



**Problem-Solving 1.27**  
Solve Problem 27 with the help of an interactive guided tutorial.


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**Figure 1.25** Refer to this map of Indianapolis, Indiana, while you do Sample Problem 1.1. **Interpreting Diagrams** *In the section of downtown bounded by north, east, south, and west streets, the main streets and avenues are named for states. What are the five exceptions to this pattern?*

## Solving Conceptual Problems

Not every word problem in chemistry requires calculations. Some problems ask you to apply the concepts you are studying to a new situation. In this text, these nonnumeric problems are labeled conceptual problems. To solve a conceptual problem, you still need to identify what is known and what is unknown. Most importantly, you still need to make a plan for getting from the known to the unknown. But if your answer is not a number, you do not need to check the units, make an estimate, or check your calculations.

The three-step problem-solving approach is modified for conceptual problems.  **The steps for solving a conceptual problem are analyze and solve.** Figure 1.26 summarizes the process, and Conceptual Problem 1.1 on the next page shows how the steps work in an actual problem.

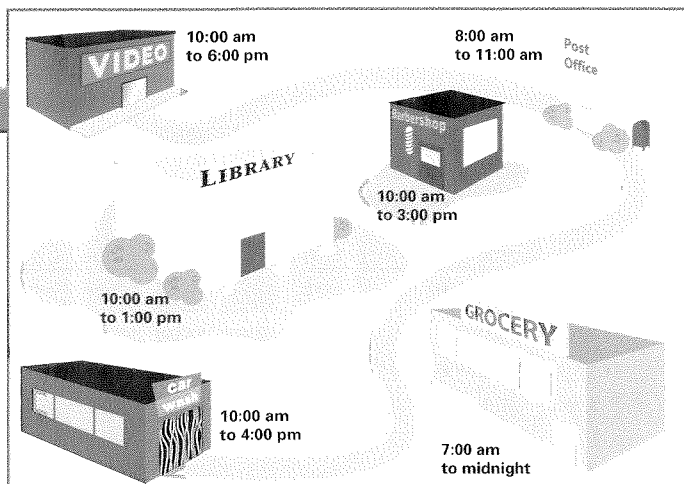


**Figure 1.26** This flowchart shows the two steps used for solving a conceptual problem. **Comparing and Contrasting** *With a conceptual problem, why is the second step called Solve rather than Calculate?*

## CONCEPTUAL PROBLEM 1.1

### Running Errands

Manny has to run 6 errands between 10 and 5 on Saturday. He must get a haircut, wash his car, buy stamps, rent a video, return a library book, and buy some groceries. Assume that each errand will take 30 minutes and that Manny will do only one errand per hour. Manny will stop for a lunch break between 12 and 1. Use the information in the drawing to figure out a way for Manny to accomplish all 6 tasks.



#### 1 Analyze *Identify the relevant concepts.*

Each place that Manny needs to visit is open for a limited number of hours on Saturday. Manny must do his errands between 10 and 12, and between 1 and 5. At a rate of one errand per hour, Manny must do 2 errands before lunch and 4 errands after lunch.

#### 2 Solve *Apply concepts to this situation.*

The post office and library are open only in the morning. The barbershop and the car wash close earlier than the video store. The supermarket is open late. One possible order for the errands is post office, library, barbershop, car wash, video store, and supermarket.

### Practice Problems

28. Describe two alternative orders in which Manny could complete his errands.
29. What if Manny had 7 errands instead of 6? What would he need to do to adjust for the extra errand?



#### Problem-Solving 1.29

Solve Problem 29 with the help of an interactive guided tutorial.

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## 1.4 Section Assessment

30. **Key Concept** What are the two general steps in successful problem solving?
31. **Key Concept** List the three steps for solving numeric problems.
32. **Key Concept** List the two steps for solving conceptual problems.
33. Read the conversion problem and then answer the questions. "There are 3600 seconds in an hour. How many seconds are there in one day?"
  - a. Identify the known and the unknown.
  - b. What relationship between the known and unknown do you need to solve the problem?
  - c. Calculate the answer to the problem.
  - d. Evaluate your answer and explain why your answer makes sense.

### Writing Activity

**Compare and Contrast Paragraph** Write a paragraph comparing the processes for solving numeric problems and conceptual problems. How are the processes similar? In what way are they different?



**Assessment 1.4** Test yourself on the concepts in Section 1.4.

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