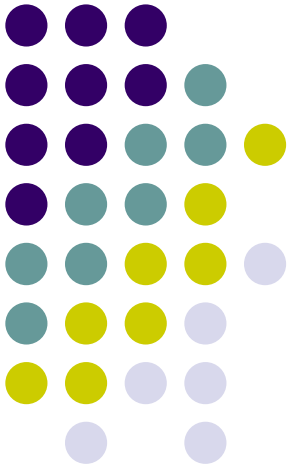
Chapter 1 Introduction to Chemistry

1.1 Chemistry



What Is Chemistry?

- **Matter** is anything that has mass and occupies space.
- **Chemistry** is the study of the composition of matter and the changes that matter undergoes.

Areas of Study

- Five traditional areas of study are
  - **organic chemistry**
  - **inorganic chemistry**
  - **biochemistry**
  - **analytical chemistry**
  - **physical chemistry**

Organic chemistry is defined as the study of all chemicals containing carbon.

Inorganic chemistry is the study of chemicals that, in general, do not contain carbon.

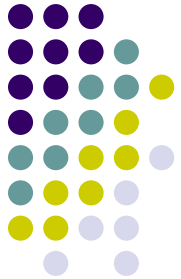
Areas of Study

The study of processes that take place in organisms is **biochemistry.**

Analytical chemistry is the area of study that focuses on the composition of matter.

Physical chemistry deals with the mechanism, rate, and energy transfer when matter undergoes a change.

Pure and Applied Chemistry

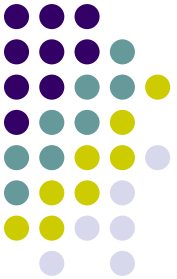


- **Pure chemistry** is the pursuit of chemical knowledge for its own sake.
- **Applied chemistry** is research that is directed toward a practical goal or application.

Pure and Applied Chemistry

- Nylon
  - In the early 1930's, Wallace Carothers produced nylon while researching cotton and silk.
  - A team of scientists and engineers applied Carothers's research to the commercial production of nylon.

Pure and Applied Chemistry



- Aspirin
  - Long before researchers figured out how aspirin works, people used it to relieve pain, and doctors prescribed it for patients who were at risk for a heart attack.
  - In 1971, it was discovered that aspirin can block the production of a group of chemicals that cause pain and lead to the formation of blood clots. This is an example of pure research.

1.1 Section Quiz

- 1. Which of these traditional areas of study mostly involve compounds containing carbon?

(1) organic chemistry

(2) inorganic chemistry

(3) biochemistry

a) (1) and (2)
b) (1) and (3)
c) (2) and (3)
d) (1), (2), and (3)

1.1 Section Quiz

- 2. Which phrase best describes applied chemistry?

  a) the pursuit of knowledge for its own sake

  b) research that answers a general question

  c) addresses fundamental aspects of a question

  d) research directed toward a practical goal

1.1 Section Quiz

- 3. Informed citizens are most likely to
  - provide funds for scientific research.
  - determine which areas of research are valid.
  - decide who is qualified to do research.
  - influence the development of technology.

1.2 Chemistry Far and Wide

Materials

- In 1948, George de Mestral took a close look at the burrs that stuck to his clothing. He saw that each burr was covered with many tiny hooks.
- In 1955, de Mestral patented the design for the hook-and-loop tapes. These are used as fasteners in shoes and gloves.

Materials

- This story illustrates two ways of looking at the world
  - Burrs belong to the **macroscopic** world - objects large enough to see with the unaided eye.
  - The hooks belong to the **microscopic** world - objects that can be seen only under magnification.

Medicine and Biotechnology

- Medicines
  - There are over 2000 prescription drugs. Many drugs are effective because they interact in a specific way with chemicals in cells. Knowledge of the structure and function of these target chemicals helps a chemist design safe and effective drugs.

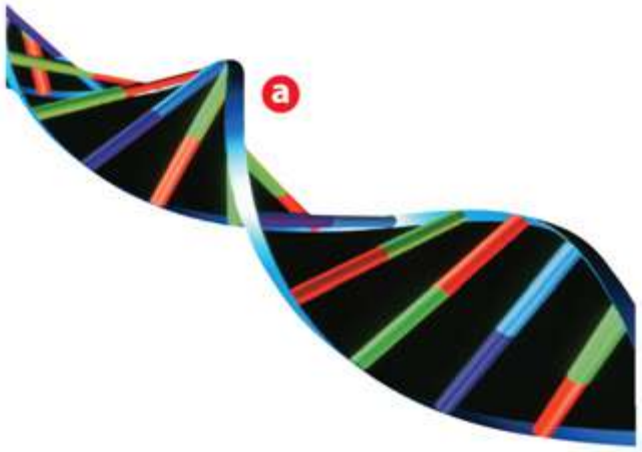
Medicine and Biotechnology

- Materials
  - Chemistry can supply materials to repair or replace body parts. Artificial hips and knees made from metals and plastics can replace worn-out joints and allow people to walk again without pain.

Medicine and Biotechnology

- Biotechnology

- From 1990 to 2003, scientists worldwide worked on the Human Genome Project. They identified the genes that comprise human DNA—about 30,000. The discovery of the structure of DNA led to the development of biotechnology.



Medicine and Biotechnology

- **Biotechnology** applies science to the production of biological products or processes.

The Environment

- The Environment
  - A **pollutant** is a material found in air, water, or soil that is harmful to humans or other organisms.
    - **Chemists help to identify pollutants and prevent pollution.**

The Environment

Identify Pollutants

- Until the mid-1900s, lead was used in many products, including paints and gasoline.
- A study done in 1971 showed that the level of lead that is harmful to humans is much lower than had been thought, especially for children. Even low levels of lead in the blood can permanently damage the nervous system of a growing child.

1.3 Thinking Like a Scientist

An Experimental Approach to Science

- Lavoisier designed a balance that could measure mass to the nearest 0.0005 gram. He also showed that oxygen is required for a material to burn.

Reconstruction of Lavoisier's Laboratory

The Scientific Method

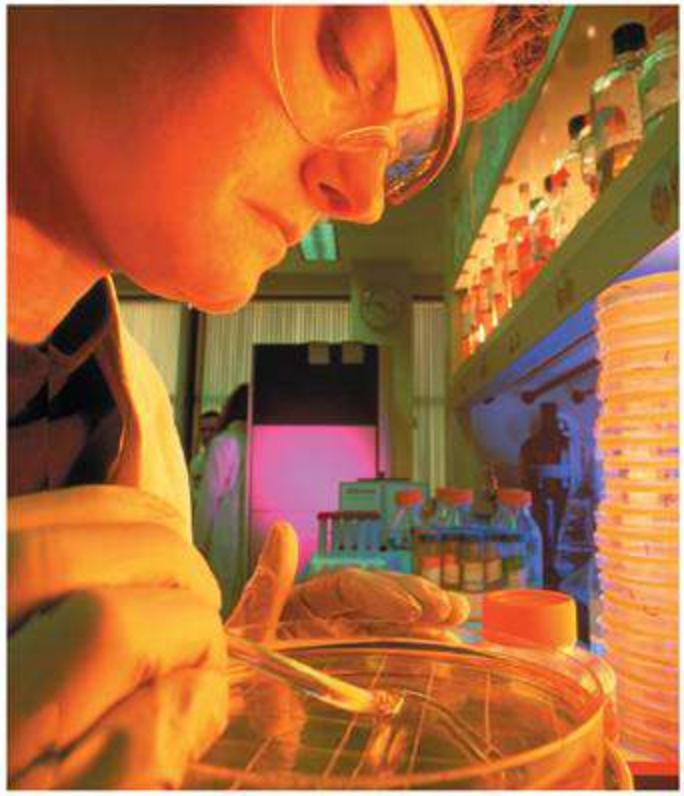
- The **scientific method** is a logical, systematic approach to the solution of a scientific problem.

  - Steps in the scientific method include making observations, testing hypotheses, and developing theories.

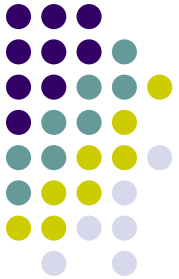
The Scientific Method

Making Observations

- When you use your senses to obtain information, you make an **observation**.
- Suppose you try to turn on a flashlight and it does not light. An observation can lead to a question: What's wrong with the flashlight?



The Scientific Method



- Testing Hypotheses
  - A **hypothesis** is a proposed explanation for an observation.
  - You guess that the flashlight needs new batteries. You can test your hypothesis by putting new batteries in the flashlight. If the flashlight lights, you can be fairly certain that your hypothesis is true.

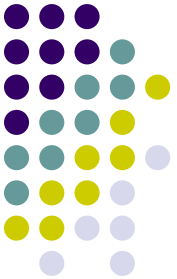
The Scientific Method

- An **experiment** is a procedure used to test a hypothesis. When you design experiments, you deal with variables, or factors that can change.
  - The variable that you change is the **manipulated variable**, or independent variable.
  - The variable that is observed during the experiment is the **responding variable**, or dependent variable.

The Scientific Method

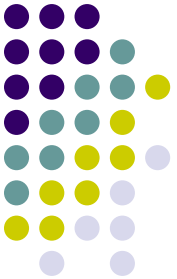
- Once a hypothesis meets the test of repeated experimentation, it may become a theory.
  - A **theory** is a well-tested explanation for a broad set of observations.
  - A theory may need to be changed at some point in the future to explain new observations or experimental results.

The Scientific Method



- Scientific Laws
  - A **scientific law** is a concise statement that summarizes the results of many observations and experiments.

1.3 Section Quiz.



- 1. Lavoisier is credited with transforming chemistry from a science of observation to a science of

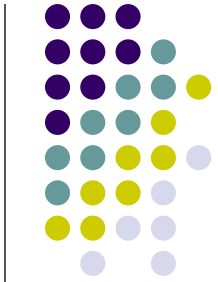
a) speculation.

b) measurement.

c) hypotheses.

d) theories.

1.3 Section Quiz.



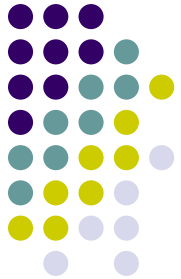
- 2. A hypothesis is

  a) information obtained from an experiment.

  b) a proposed explanation for observations.

  c) a concise statement that summarizes the results of many of experiments.

  d) a thoroughly tested explanation for a broad set of observations.



1.4 Problem Solving in Chemistry

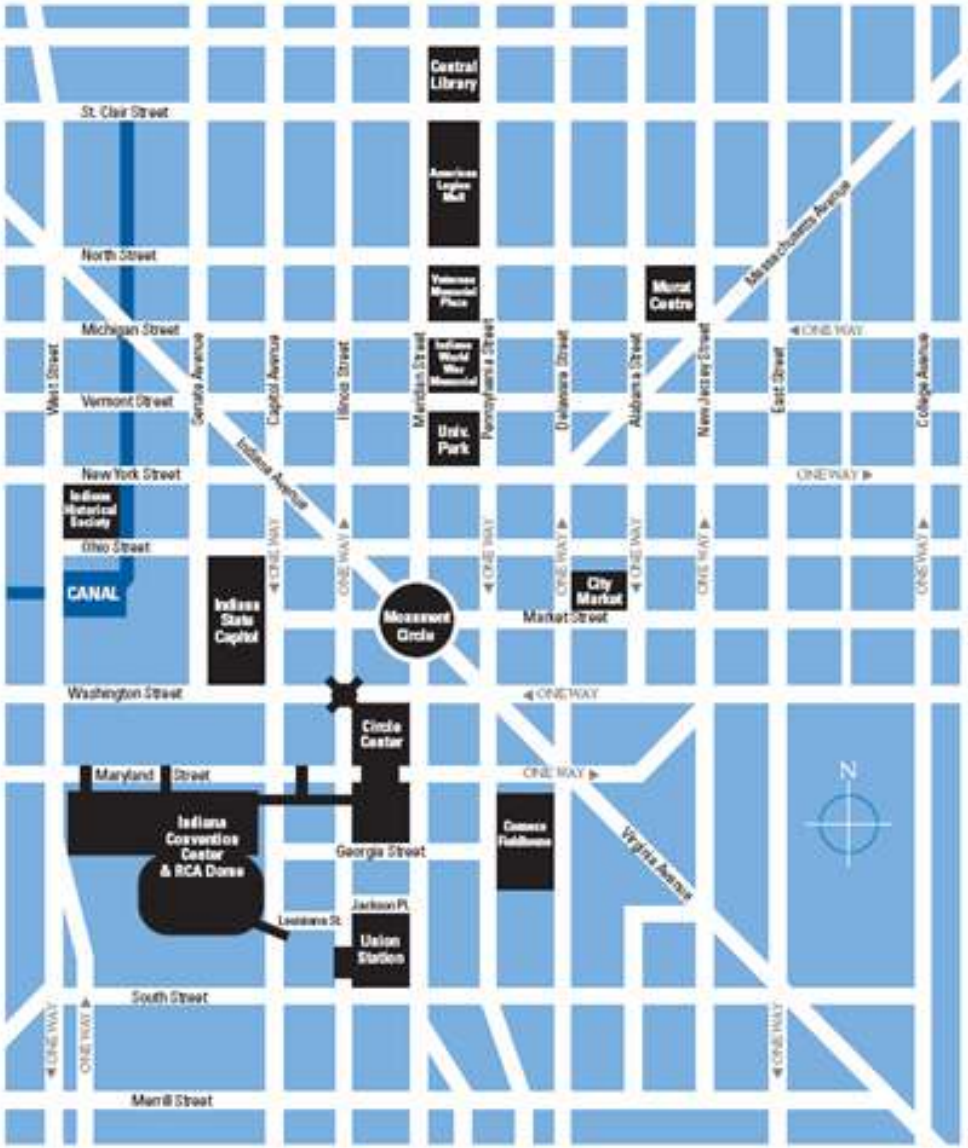
Sample Problem 1.1

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.

1.1

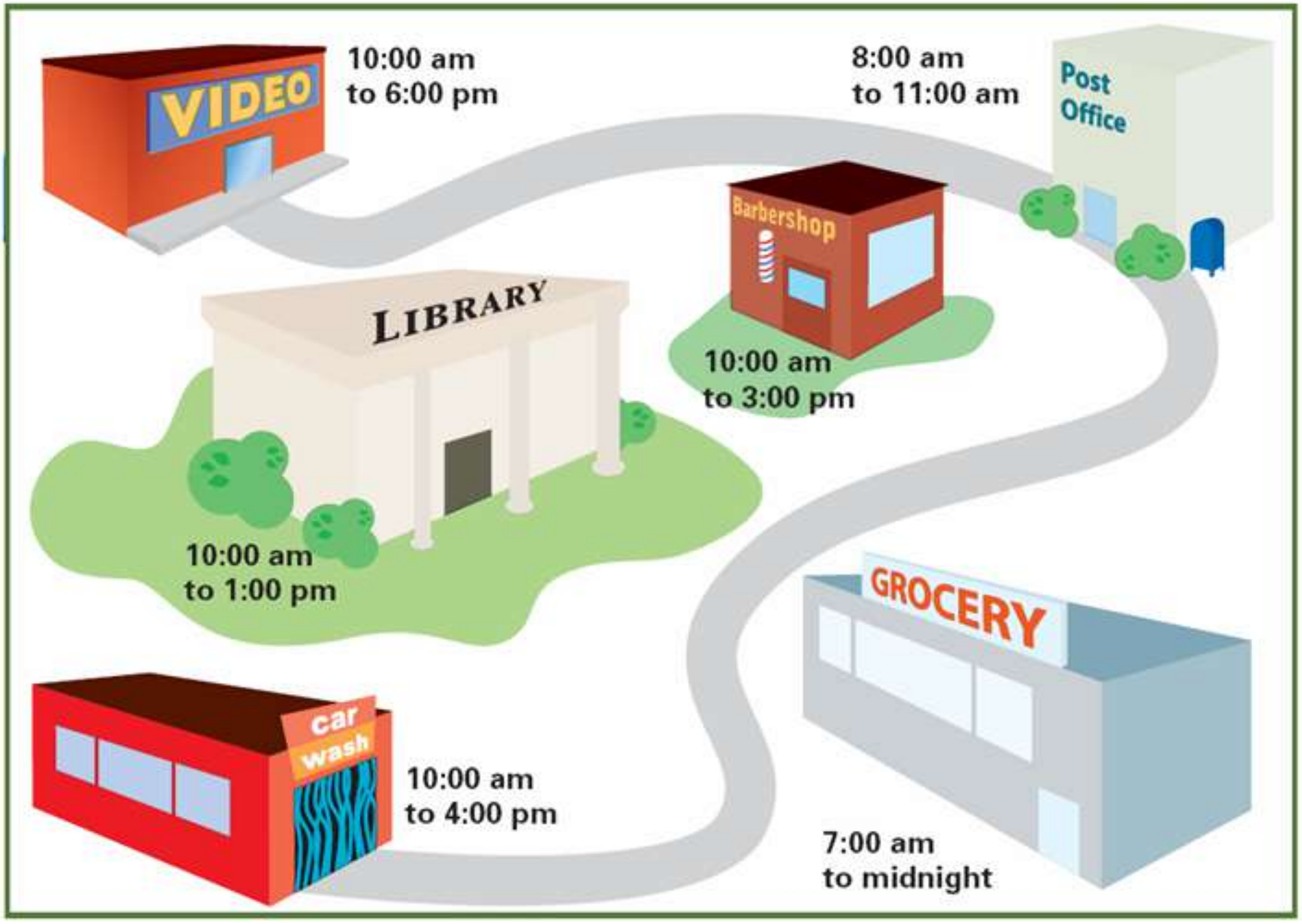
Figure 1.25 Map of Indianapolis



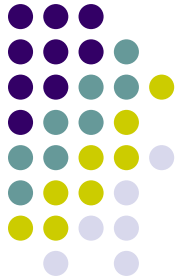
27. There is an ice cream shop 6 blocks north of your hotel. How many minutes will it take to walk there and back?

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.


VIDEO
10:00 am
to 6:00 pm
8:00 am
to 11:00 am
Post
Office
Barbershop
10:00 am
to 3:00 pm
LIBRARY
10:00 am
to 1:00 pm
GROCERY
car
wash
10:00 am
to 4:00 pm
7:00 am
to midnight

for Conceptual Problem 1.1



29. What if Manny had 7 errands instead of 6? What would he need to do to adjust for the extra errand?