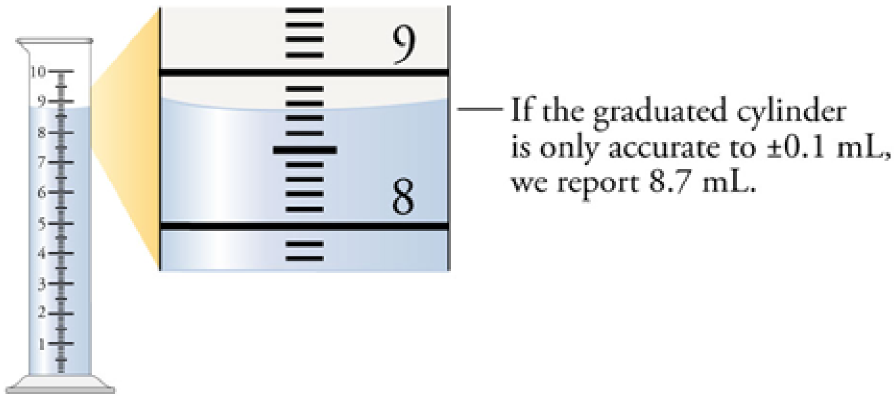
Chapter 1
An Introduction to Chemistry



Section Goals and Introductions

Section 1.1 What Is Chemistry, and What Can Chemistry Do for You?

Goal: To explain a bit about what chemistry is and why it's important.

This section shows you some of the questions that an understanding of chemistry helps to answer and some of the issues of concern to chemists.

Throughout the text, you will see Special Topics, such as *Special Topic 1.1: Green Chemistry*, that will reinforce the attitude that chemistry is an important science that expands our understanding of the world around us and helps us to change that world, often in ways that are beneficial to us and to our environment.

This section ends with a commercial message: you cannot get the benefits that an understanding of chemistry brings without first concentrating on the basics, which are not always very interesting and which do not always seem directly related to the real world. Trust me. If you master the basics, you will be explaining the way the physical world works to your friends and family in no time.

Section 1.2 Suggestions for Studying Chemistry

Goals

- *To suggest some study strategies.*
- *To introduce you to some of the unique components of the text.*

It's very important that you understand from the beginning of the course that learning chemistry is a time-consuming task that is best approached in a logical and efficient way. So one goal of this section is to make some suggestions to you about how you might study most efficiently.

Another goal is to be sure that you know the tools that you have available to help you. Be sure you know where to find and how to use each of the following: Review Skills, Examples, Exercises, Internet tools, Glossary, Objectives, and End-of-Chapter Problems.

http://www.preparatorychemistry/

I want to stress the importance of one of these somewhat unique components, the Objectives. An attempt has been made to write an objective for every skill that you should learn from the text. If you can meet the objectives, you will ace the exams. Be sure to ask your instructor about changes to the list. It's difficult to use someone else's objectives, so your instructor is likely to add objectives and eliminate some of those found in the text.

Section 1.3 The Scientific Method

Goal: To give you an idea of how science is done.

This section describes one way that science is done and shows how this method was applied in the development of an understanding of Parkinson's disease and in the development of treatments for it.

Section 1.4 Measurement and Units

Goal: To introduce units of measurement.

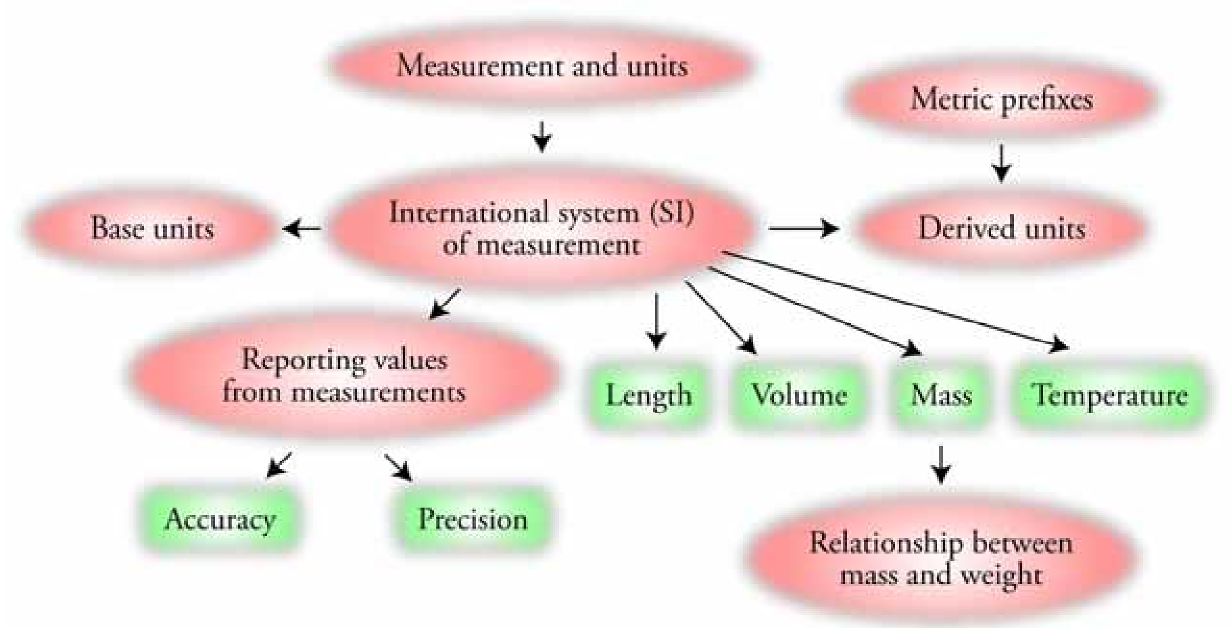
In this section, you will learn that a *value* contains a *number* and a *unit*, and you will learn a lot about the units used in the International System of Measurement (SI). When you are done studying this section, be sure that you know the common SI units used to describe length, volume, mass, and temperature. It is important that you be able to write the relationship between metric units derived from the metric prefixes and the base unit for that same type of measurement. (See Example 1.1.) This section also shows you the relative sizes of English and metric units and explains the difference between mass and weight (two terms that are often confused).

Section 1.5 Reporting Values from Measurements

Goal: To show how scientists report values from measurements.

This section is especially important for students who are taking a course with a laboratory section included. It describes some of the factors that a scientist considers when deciding how to report values derived from measurements.

Chapter Map (Sections 1.4 and 1.5)



Chapter Checklist

- ☐ Read the chapter quickly before the lecture that describes it.
- ☐ Attend class meetings, take notes, and participate in class discussions.
- ☐ Work the Chapter Exercises, perhaps using the Chapter Examples as guides.
- ☐ Study the Chapter Glossary and test yourself on our Web site:

  Internet: Glossary Quiz
- ☐ Study all of the Chapter Objectives. You might want to write a description of how you will meet each objective. (Although it is best to master all of the objectives, the following objectives are especially important because they pertain to skills that you will need while studying other chapters of this text: 3, 4, 5, 6, 7, 10, 11, 14, and 19.)

☐ Memorize the following. (Be sure to check with your instructor to determine how much you are expected to know of the following.)

- *SI base units* (Table 1.1) The table below contains the four base units that you should know now.

Type of Measurement	Base Unit	Abbreviation
Length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

- *Metric prefixes* (Table 1.2) The table below contains the most common of these prefixes.

Prefixes for large units			Prefixes for small units		
Prefix	**Abbreviation**	**Value**	**Prefix**	**Abbreviation**	**Value**
giga	G	1,000,000,000 or 10^9	centi	c	0.01 or 10^{-2}
mega	M	1,000,000or 10^6	milli	m	0.001 or 10^{-3}
kilo	k	1000 or 10^3	micro	μ	0.000001 or 10^{-6}

☐ To get a review of the most important topics in the chapter, fill in the blanks in the Key Ideas section.

☐ Work all of the selected problems at the end of the chapter, and check your answers with the solutions provided in this chapter of the study guide.

☐ Ask for help if you need it.

Web Resources

The Web resources that are available for this course require that you have the tools listed below. As of this writing, the following links will take you to Web sites where you can download the latest browsers and the Shockwave plug-in.

MS Explorer Browser: **www.microsoft.com/windows/ie/download/windows.htm**

Shockwave: **sdc.shockwave.com/shockwave/download/**

There's a glossary quiz in Chapter 1 of our Web site that provides the definitions for each of the glossary terms and asks you to type in the term.

Internet: Glossary Quiz

Exercises Key

Exercise 1.1 - Units Derived from Metric Prefixes: Complete the following relationships. Rewrite the relationships using abbreviations for the units. *(Obj 7)*

a. 1 megagram = $\mathbf{10^{6}}$ gram b. 1 milliliter = $\mathbf{10^{-3}}$ liter

Exercise 1.2 – Uncertainty: If you are given the following values that are derived from measurements, what will you assume is the range of possible values that each represents? *(Obj 19)*

a. 72 mL **71 mL to 73 mL**
b. 8.23 m **8.22 m to 8.24 m**
c. 4.55×10^{-5} g $\mathbf{4.54 \times 10^{-5}}$ **g to** $\mathbf{4.56 \times 10^{-5}}$ **g**

Exercise 1.3 - Uncertainty in Measurement: Let's assume that four members of your class are asked to measure the mass of a dime. The reported values are 2.302 g, 2.294 g, 2.312 g, and 2.296 g. The average of these values is 2.301 g. Considering the values reported and the level of care you expect beginning chemistry students to take with their measurements, how would you report the mass so as to communicate the uncertainty of the measurement? *(Obj 18)*

2.30 g because the reported values differ by about ±0.01.

Key Ideas Answers

1. Complete this brief description of common steps in the development of scientific ideas: The process begins with **observation** and the collection of **data**. Next, scientists make an initial **hypothesis**. This leads to a more purposeful collection of information in the form of systematic **research or experimentation**. The hypothesis is refined on the basis of the new information, and **research** is designed to test the hypothesis. The results are **published** so that other scientists might repeat the research and confirm or refute the conclusions. If other scientists confirm the results, the hypothesis becomes accepted in the scientific community. The next step of this scientific method is a search for useful **applications** of the new ideas. This often leads to another round of **hypothesizing and testing** in order to refine the applications.
3. The **meter**, which has an abbreviation of **m**, is the accepted SI base unit for length.
5. The **second**, which has an abbreviation of s, is the accepted SI base unit for **time**.
7. Many properties cannot be described directly with one of the seven SI **base units**. Rather than create new definitions for new units, we **derive** units from the units of meter, kilogram, second, kelvin, mole, ampere, and candela.
9. An object's weight on the surface of the earth depends on its **mass** and on the **distance** between it and the center of the earth.
11. The thermometers that scientists use to measure temperature generally provide readings in degrees **Celsius**, but scientists usually convert these values into **Kelvin** values to do calculations.
13. One of the conventions that scientists use for reporting measurements is to report all of the **certain** digits and one **estimated** (and thus uncertain) digit.

Problems Key

Section 1.4 Measurement and Units

15. Complete the following table by writing the property being measured (mass, length, volume, or temperature) and either the name of the unit or its abbreviation. *(Objs 3 and 7)*

Unit	Type of measurement	Abbreviation	Unit	Type of measurement	Abbreviation
megagram	**mass**	**Mg**	nanometer	**length**	**nm**
milliliter	**volume**	mL	**kelvin**	**temperature**	K

17. Convert the following ordinary numbers to scientific notation. (See Appendix B at the end of the textbook if you need help with this.)
    a. 1,000 = $\mathbf{10^{3}}$
    b. 1,000,000,000 = $\mathbf{10^{9}}$
    c. 0.001 = $\mathbf{10^{-3}}$
    d. 0.000000001 = $\mathbf{10^{-9}}$

19. Convert the following numbers expressed in scientific notation to ordinary numbers. (See Appendix B at the end of the textbook if you need help with this.)
    a. 10^{7} = **10,000,000**
    b. 10^{12} = **1,000,000,000,000**
    c. 10^{-7} = **0.0000001**
    d. 10^{-12} = **0.000000000001**

21. Complete the following relationships between units. *(Objs 6, 10, and 14)*
    a. $\mathbf{10^{3}}$ m = 1 km
    b. $\mathbf{10^{-3}}$ L = 1 mL
    c. $\mathbf{10^{6}}$ g = 1 Mg
    d. **1** cm^{3} = 1 mL
    e. $\mathbf{10^{3}}$ kg = 1 t (t = metric ton)

23. Would each of the following distances be closest to a millimeter, a centimeter, a meter, or a kilometer? *(Obj 8)*
    a. the width of a bookcase **meter**
    b. the length of an ant **centimeter**
    c. the width of the letter "t" in this phrase **millimeter**
    d. the length of the Golden Gate Bridge in San Francisco **kilometer**

25. Which is larger, a centimeter or an inch?
    There are 2.54 centimeters per inch, so an inch is larger.

27. Would the volume of each of the following be closest to a milliliter, a liter, or a cubic meter? *(Obj 9)*
    a. a vitamin tablet **milliliter**
    b. a kitchen stove and oven **cubic meter**
    c. this book **liter**

29. Which is larger, a milliliter or a fluid ounce?
    There are 29.57 milliliters per fluid ounce, so a fluid ounce is larger.

31. Explain the difference between mass and weight. *(Obj 11)*

Mass is usually defined as a measure of the amount of matter in an object. The *weight* of an object, on Earth, is a measure of the force of gravitational attraction between the object and Earth. The more mass an object has, the greater the gravitational attraction between it and another object. The farther an object gets from Earth, the less that attraction is, and the lower its weight. Unlike the weight of an object, the mass of an object is independent of location. Mass is described with mass units, such as grams and kilograms. Weight can be described with force units, such as newtons.

32. Which is larger, a gram or an ounce?

There are 28.35 grams per ounce, so an ounce is larger.

36. Which is larger, a degree Celsius or a degree Fahrenheit?

There are 1.8 degrees Fahrenheit per degree Celsius, so a degree Celsius is larger.

38. Which is the smallest increase in temperature: 10 °C (such as from 100 °C to 110 °C), 10 K (such as from 100 K to 110 K), or 10 °F (such as from 100 °F to 110 °F)? *(Obj 16)*

10 °F

Section 1.5 Reporting Values from Measurements

41. Given the following values that are derived from measurements, what do you assume is the range of possible values that each represents? *(Obj 19)*

We assume ±1 in the last decimal place reported.

a. 30.5 m (the length of a whale)

30.5 m means 30.5 ± 0.1 m or 30.4 m to 30.6 m.

b. 612 g (the mass of a basketball)

612 g means 612 ± 1 g or 611 g to 613 g.

c. 1.98 m (Michael Jordan's height)

1.98 m means 1.98 ± 0.01 m or 1.97 m to 1.99 m.

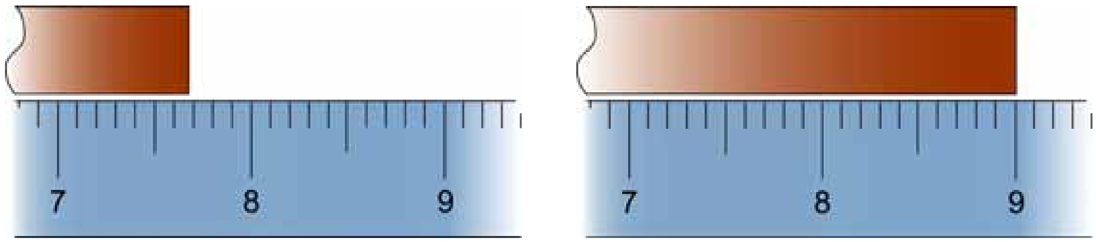
d. 9.1096×10^{-28} g (the mass of an electron)

9.1096×10^{-28} g means $(9.1096 \pm 0.0001) \times 10^{-28}$ g
or 9.1095×10^{-28} g to 9.1097×10^{-28} g.

e. 1.5×10^{18} m^3 (the volume of the ocean)

1.5×10^{18} m^3 means $(1.5 \pm 0.1) \times 10^{18}$ m^3 or 1.4×10^{18} m^3 to 1.6×10^{18} m^3.

43. The accompanying drawings show portions of metric rulers on which the numbers correspond to centimeters. The dark bars represent the ends of objects being measured. *(Obj 18)*



a. If you were not given any specific instructions for reporting your values, what length would you record for each of these measurements?

It's difficult to estimate the hundredth position accurately. For the object on the left, we might report 7.67 cm, 7.68 cm, or 7.69. The end of the right object seems to be right on the 9 cm mark, so we report 9.00 cm.

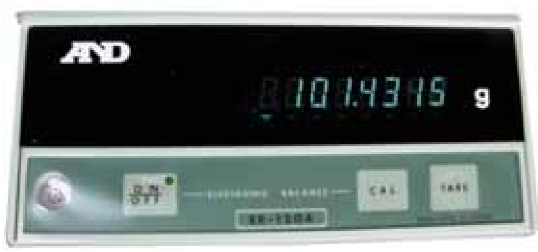
b. If you were told that the lines on the ruler are drawn accurately to ±0.1 cm, how would you report these two lengths?

7.7 cm and 9.0 cm

45. At a track meet, three different timers report the times for the winner of a 100-m sprint as 10.51 s, 10.32 s, and 10.43 s. The average is 10.42 s. How would you report the time of the sprinter in a way that reflects the uncertainty of the measurements? *(Obj 18)*

Our uncertainty is in the tenth position, so we report 10.4 s.

47. The image below represents the digital display on a typical electronic balance. *(Obj 19)*



a. If the reading represents the mass of a solid object that you carefully cleaned and dried and then handled without contaminating it, how would you report this mass?

101.4315 g

b. Now assume that the reading is for a more casually handled sample of a liquid and its container. Let's assume not only that you were less careful with your procedure this time but also that the liquid is evaporating rapidly enough for the reading to be continually decreasing. In the amount of time that the container of liquid has been sitting on the pan of the balance, the mass reading has decreased by about 0.001 g. How would you report the mass?

Our convention calls for only reporting one uncertain digit in our value. Because we are uncertain about the thousandth position, we might report 101.432 g (or perhaps even 101.43 g)