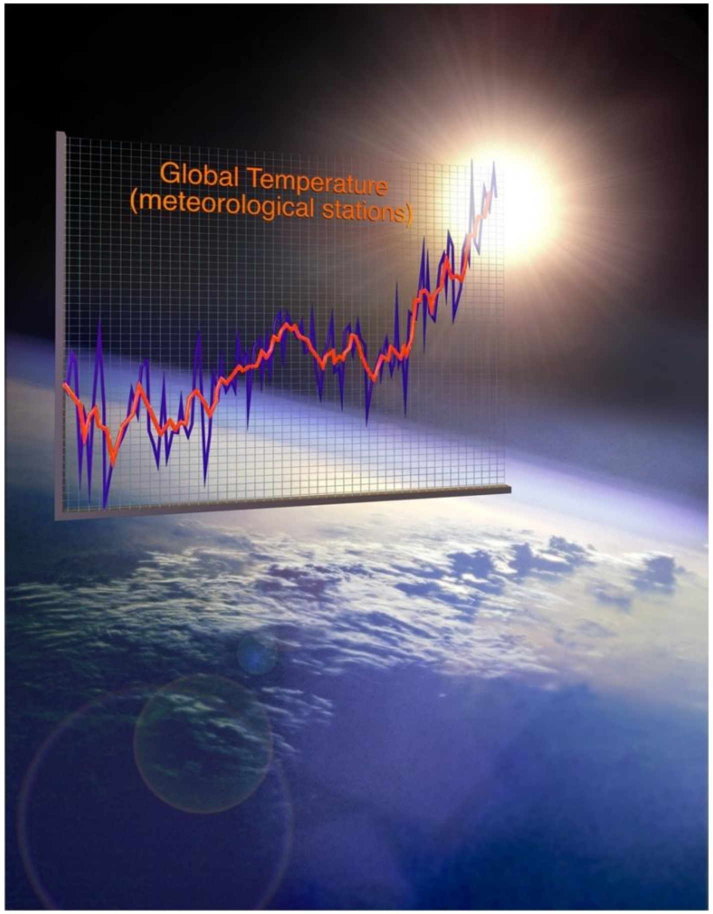
Chapter 2
Measurement and Problem Solving



What Is a Measurement?

- Quantitative observation.
- Comparison to an agreed upon standard.
- Every measurement has a number and a unit.

A Measurement

- The unit tells you to what standard you are comparing your object.
- The number tells you:
  1. What multiple of the standard the object measures.
  2. The uncertainty in the measurement.

Scientific Notation

A way of writing
large and small numbers.

Big and Small Numbers

- Writing large numbers of zeros is tricky and confusing.
  - ✓ Not to mention there's the 8-digit limit of your calculator!

The sun's diameter is 1,392,000,000 m.

An atom's average diameter is 0.000 000 000 3 m.

Scientific Notation

- Each decimal place in our number system represents a different power of 10
- Scientific notation writes the numbers so they are easily comparable by looking at the power of 10

The sun's diameter is 1.392×10^{9} m.

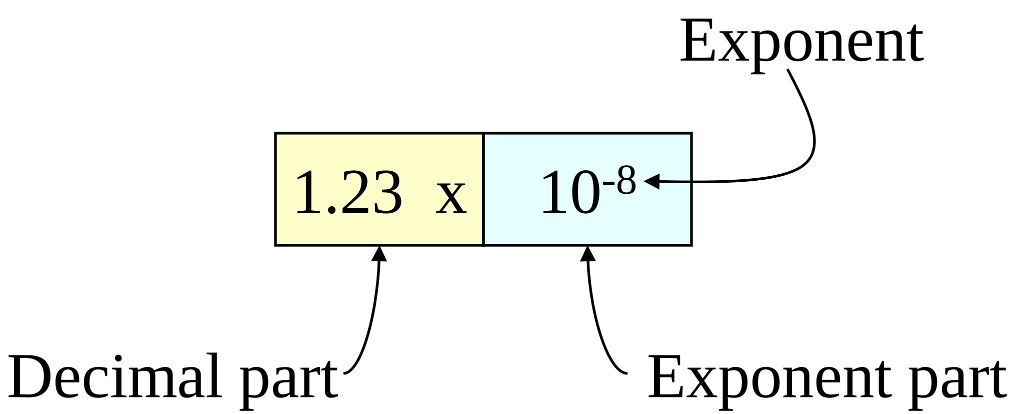
An atom's average diameter is 3×10^{-10} m.

Exponents

- When the exponent on 10 is positive, it means the number is that many powers of 10 larger.
  - ✓Sun's diameter = 1.392 x 10^9 m = 1,392,000,000 m.
- When the exponent on 10 is negative, it means the number is that many powers of 10 smaller.
  - ✓Average atom's diameter = 3 x 10^{-10} m = 0.0000000003 m.

Scientific Notation

- To compare numbers written in scientific notation:
  - ✓First compare exponents on 10.
  - ✓If exponents are equal, then compare decimal numbers



$1.23 \times 10^{5} > 4.56 \times 10^{2}$

$4.56 \times 10^{-2} > 7.89 \times 10^{-5}$

$7.89 \times 10^{10} > 1.23 \times 10^{10}$

Writing a Number in Scientific Notation:

Example: Write 12340 in scientific notation

The steps to be taken are:

12340

1. Locate the decimal point.

12340.

2. Move the decimal point to obtain a number between **1** and **10**.

1.2340

3. Multiply the new number by 10^n .
   - ✓ Where ***n*** is the number of places you moved the decimal point.

1.2340×10^4

4. If you moved the decimal point to the left, then ***n*** is +; if you moved it to the right, then ***n*** is − .

1.2340×10^4

Writing a Number in Scientific Notation, Continued

0.00012340

1. Locate the decimal point.

0.00012340

2. Move the decimal point to obtain a number between **1** and **10**.

1.2340

3. Multiply the new number by 10^{n} .
   - ✓ Where ***n*** is the number of places you moved the decimal point.

1.2340×10^{4}

4. If you moved the decimal point to the left, then ***n*** is +; if you moved it to the right, then ***n*** is − .

1.2340×10^{-4}

Writing a Number in Standard Form

1.234×10^{-6}

- Since exponent is -6, make the number smaller by moving the decimal point to the left 6 places.
  - ✓ When you run out of digits to move around, add zeros.
  - ✓ Add a zero in front of the decimal point for decimal numbers.

000 001.234

0.000 001 234

Practice—Write the Following in Scientific Notation

123.4	8.0012
145000	0.00234
25.25	0.0123
1.45	0.000 008706

Practice—Write the Following in Standard Form

2.1×10^3

4.02×10^0

9.66×10^{-4}

3.3×10^1

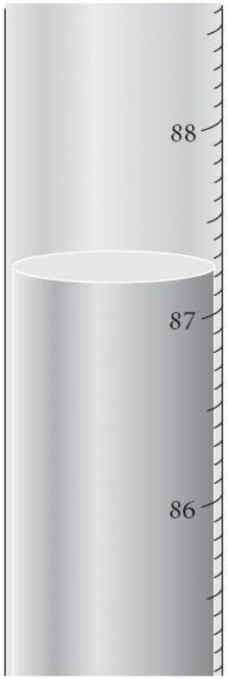
6.04×10^{-2}

1.2×10^0

Significant Figures

Writing numbers to reflect precision.

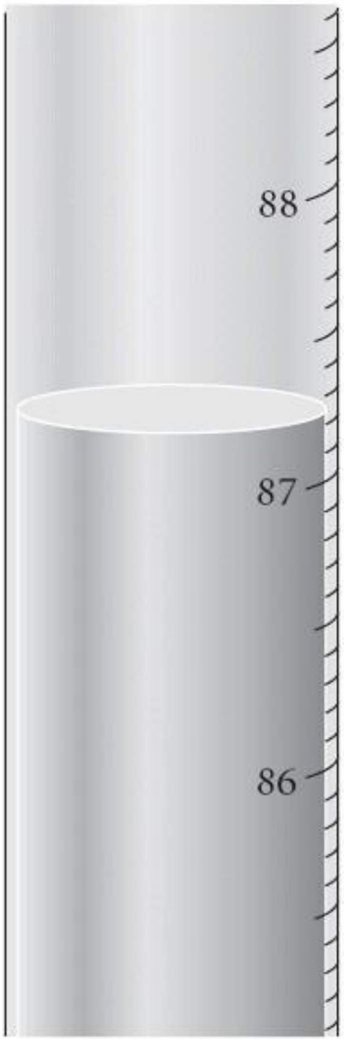
Exact Numbers vs. Measurements



- Sometimes you can determine an **exact** value for a quantity of an object.
  - ✓ Often by counting.
- Whenever you use an instrument to compare a quantity of an object to a standard, there is **uncertainty** in the comparison.

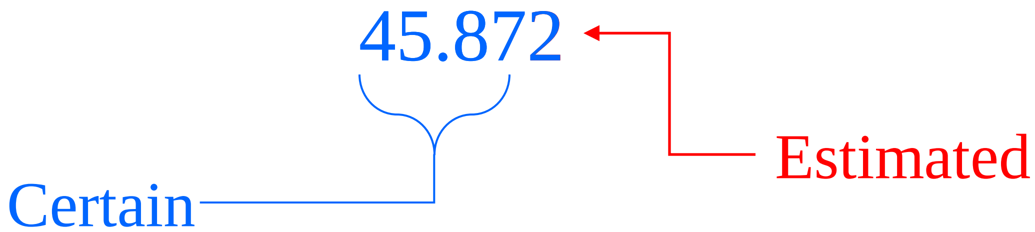
Estimating the Last Digit

- Determine the last digit by estimating between the marks
- Mentally divide the gap between marks into tenths, then estimate which tenth the indicator mark would be pointing toward



Reporting Measurements

- Measurements are written to indicate the uncertainty in the measurement.
- The system of writing measurements we use is called **significant figures.**
- When writing measurements, all the digits written are known with certainty except the last one, which is an estimate.



Skillbuilder 2.3—Reporting the Right Number of Digits

- A thermometer used to measure the temperature of a backyard hot tub is shown to the right. What is the temperature reading to the correct number of digits?

Significant Figures

How precise are our measurements?

- The precision of a measurement depends on the number of *significant figures*
- Significant figures are the meaningful digits in a measurement
- The last digit in any measurement is usually estimated and is known as the least significant digit
    - ✓ *e.g.*, in 5.342 cm, the digit 2 is the least significant

Significant Figures in Measurements

- There is no absolute certainty in any measurement
- The actual value of all measurements always lie in a range
  - ✓*e.g.*, a measurement of 6 mL means the actual value lies in the range 5 mL – 7 mL
  - ✓a measurement of 6.2 mL means the actual value 6.1 mL – 6.3 mL
- The more significant digits you have, the more certain your measurement .

Guidelines for Counting Significant Figures

1) All nonzero digits are significant.
   - ✓ 1.5 has 2 sig. figs.
   - ✓ 381 has 3 sig. figs.

2) Interior zeroes are significant.
   - ✓ 1.05 has 3 sig. figs.
   - ✓ 1.005 has 4 sig. figs.

3) Leading zeroes are **NOT** significant.
   - ✓ 0.001050 has 4 sig. figs.
   - ✓ 0.00004 has 1 sig. figs.

Guidelines for Counting Significant Figures

4) Trailing zeroes MAY or MAY NOT be significant
   a) Trailing zeroes after a decimal point are significant
      - 1.050 has 4 sig. figs.
   b) Trailing zeroes before a decimal point and after the nonzero digit is significant
      - 150.0 has 4 sig. figs.
   c) Zeroes at the end of a number without a written decimal point are **ambiguous** and should be avoided by using scientific notation
      - if 150 has 2 sig. figs. then 1.5×10^2
      - but if 150 has 3 sig. figs. then 1.50×10^2

CAUTION: Sig. Figs.

Some textbooks put a decimal point after the trailing zeroes if the zeroes are to be considered significant.

e.g., if the zero in 150 is to be considered significant, then it is written as 150.

Therefore:

150. has 3 sig. figs.

2000. has 4 sig. figs.

Significant Figures and Exact Numbers

- A number whose value is known with complete certainty is **exact**.
  - ✓ from counting individual objects
  - ✓ from definitions
    - ➢ 1 cm is exactly equal to 0.01 m
  - ✓ from integer values in equations
    - ➢ in the equation for the radius of a circle, the 2 is exact

$$\text{radius of a circle} = \frac{\text{diameter of the circle}}{2}$$

- Exact numbers have an unlimited number of significant figures.

Example 2.4—Determining the Number of Significant Figures in a Number, Continued

- How many significant figures are in each of the following numbers?

0.0035	2 significant figures—leading zeros are not significant.
1.080	4 significant figures—trailing and interior zeros are significant.
2371	4 significant figures—All digits are significant.
2.97×10^5	3 significant figures—Only decimal parts count as significant.
1 dozen = 12	Unlimited significant figures—Definition
100,000	Ambiguous

Example: Determine the Number of Significant Figures, the Expected Range of Precision, and Indicate the Last Significant Figure

- 12000
- 0.0012
- 120.
- 0.00120
- 12.00
- 1201
- 1.20×10^3
- 1201000

Determine the Number of Significant Figures, the Expected Range of Precision, and Indicate the Last Significant Figure, Continued

- 12000 **2**

From 11000 to 13000.

- 0.0012 **2**

From 0.0011 to 0.0013.

- 120. **3**

From 119 to 121.

- 0.00120 **3**

From 0.00119 to 0.00121.

- 12.00 **4**

From 11.99 to 12.01.

- 1201 **4**

From 1200 to 1202.

- 1.20×10^3 **3**

From 1190 to 1210.

- 1201000 **4**

From 1200000 to 1202000.

FACT CHECK

How many significant figures are in each of the following numbers

a) 554 km b) 7 pennies c) 1.01×10^5 m

d) 0.00099 s e) 1.4500 Km f) 21,000 m

FACT CHECK

Determine the number of significant figures, the expected range of precision, and indicate the last significant figure

0.00120 b) 120. c) 12.00 d) 1.23

Multiplication and Division with Significant Figures

- When multiplying or dividing measurements with significant figures, the result has the same number of significant figures as the measurement with the fewest number of significant figures.

$$5.02 \times 89{,}665 \times 0.10 = 45.0118 = 45$$

3 sig. figs. 5 sig. figs. 2 sig. figs. 2 sig. figs.

$$5.892 \div 6.10 = 0.96590 = 0.966$$

4 sig. figs. 3 sig. figs. 3 sig. figs.

Rounding

- When rounding to the correct number of significant figures, if the number after the place of the last significant figure is:

1. 0 to 4, round down.
   - ✓ Drop all digits after the last significant figure and leave the last significant figure alone.
   - ✓ Add insignificant zeros to keep the value, if necessary.
2. 5 to 9, round up.
   - ✓ Drop all digits after the last significat figure and increase the last significant figure by one.
   - ✓ Add insignificant zeros to keep the value, if necessary.

Rounding, Continued

- Rounding to 2 significant figures.
- 2.34 rounds to 2.3
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.
- 2.37 rounds to 2.4
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 5 or greater.
- 2.349865 rounds to 2.3
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.

Rounding, Continued

- 0.0234 rounds to 0.023 or 2.3×10^{-2}.
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.
- 0.0237 rounds to 0.024 or 2.4×10^{-2}.
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 5 or greater.
- 0.02349865 rounds to 0.023 or 2.3×10^{-2}.
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.

Rounding, Continued

- 234 rounds to 230 or 2.3×10^2 .
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.
- 237 rounds to 240 or 2.4×10^2 .
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 5 or greater.
- 234.9865 rounds to 230 or 2.3×10^2 .
  - ✓ Because the 3 is where the last significant figure will be and the number after it is 4 or less.

Example: Determine the Correct Number of Significant Figures for Each Calculation and Round and Report the Result

1. $1.01 \times 0.12 \times 53.51 \div 96 = 0.067556$

2. $56.55 \times 0.920 \div 34.2585 = 1.51863$

Determine the Correct Number of Significant Figures for Each Calculation and Round and Report the Result, Continued

1. $1.01 \times 0.12 \times 53.51 \div 96 = 0.067556 = 0.068$

3 sf | 2 sf | 4 sf | 2 sf

Result should have 2 sf.

7 is in place of last sig. fig., number after is 5 or greater, so round up.

2. $56.55 \times 0.920 \div 34.2585 = 1.51863 = 1.52$

4 sf | 3 sf | 6 sf

Result should have 3 sf.

1 is in place of last sig. fig., number after is 5 or greater, so round up.

Addition and Subtraction with Significant Figures

- When adding or subtracting measurements with significant figures, the result has the same number of decimal places as the measurement with the fewest number of decimal places.

5.74	+	0.823	+	2.651	=	9.214	=	9.21
2 dec. pl.		3 dec. pl.		3 dec. pl.				2 dec. pl.
4.8	-	3.965			=	0.835	=	0.8
1 dec. pl		3 dec. pl.						1 dec. pl.

Example: Determine the Correct Number of Significant Figures for Each Calculation and Round and Report the Result

1. 0.987 + 125.1 – 1.22 = 124.867

2. 0.764 – 3.449 – 5.98 = -8.664

Determine the Correct Number of Significant Figures for Each Calculation and Round and Report the Result, Continued

1. 0.987 + 125.1 – 1.22 = 124.867 = 124.9

3 dp · 1 dp · 2 dp · Result should have 1 dp.

8 is in place of last sig. fig., number after is 5 or greater, so round up.

2. 0.764 – 3.449 – 5.98 = -8.664 = -8.66

3 dp · 3 dp · 2 dp · Result should have 2 dp.

6 is in place of last sig. fig., number after is 4 or less, so round down.

Both Multiplication/Division and Addition/Subtraction with Significant Figures

- When doing different kinds of operations with measurements with significant figures, evaluate the significant figures in the intermediate answer, then do the remaining steps.
- Follow the standard order of operations.

$$(\ ) \rightarrow {}^{n} \rightarrow \times \div \rightarrow + -$$

$$3.489 \times (5.67 - 2.3) =$$

2 dp 1 dp

$$3.489 \times 3.\underline{3}7 = 11.7579 = 12$$

4 sf 1 dp & 2 sf 2 sf

Example 1.6—Perform the Following Calculations to the Correct Number of Significant Figures

a) $1.10 \times 0.5120 \times 4.0015 \div 3.4555$

b)
$$\begin{array}{r} 0.355 \\ +105.1 \\ -100.5820 \\ \hline \end{array}$$

c) $4.562 \times 3.99870 \div (452.6755 - 452.33)$

d) $(14.84 \times 0.55) - 8.02$

Example 1.6—Perform the Following Calculations to the Correct Number of Significant Figures, Continued

a) $1.10 \times 0.5120 \times 4.0015 \div 3.4555 = 0.65219 = 0.652$

b)
$$\begin{array}{r} 0.355 \\ +105.1 \\ \underline{-100.5820} \\ 4.8730 = 4.9 \end{array}$$

c) $4.562 \times 3.99870 \div (452.6755 - 452.33) = 52.79904 = 53$

d) $(14.84 \times 0.55) - 8.02 = 0.142 = 0.1$

Measurements and Units

- In order to study the properties of matter, certain measurements (*such as temperature*, *boiling point*, *freezing point*, *mass*) need to be taken
- When these measurements are taken, they are expressed in standard quantities known as units

The units of measurements

There are two common unit systems:

- A) the English system, used in the united states and consists of units such as *miles*, *pounds*, *inches* etc.

- B) the Metric system, used by the rest of the world and consists of units such as *kilometers*, *kilograms*, *centimeters* etc.
- Scientists however use Standard Units which are based on the metric system. This scientific unit system is called the International System of Units (SI).

  Note that the abbreviation SI is from the French equivalent known as *Systeme International*.

The Standard Units

There are several standard units used in science. For now we will focus on the standard units for quantities such as *length, mass, time* and *temperature.*

NB: Standard units are also known as SI units

Quantity	**Unit**	**Symbol**
length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

Length

- Measure of the two-dimensional distance an object covers.
- SI unit = meter (m)
  - ✓Note that the symbol of meter is *m* (lower case m). Upper case M does not represent the unit of measurement of length
- Commonly use centimeters (cm).
  - ✓1 m = 100 cm
  - ✓1 cm = 0.01 m = 10 mm
  - ✓1 inch = 2.54 cm (exactly)

Yardstick

Meterstick

Common Units and Their Equivalents

Length

1 kilometer (km)	=	0.6214 mile (mi)
1 meter (m)	=	39.37 inches (in)
1 meter (m)	=	1.094 yards (yd)
1 foot (ft)	=	30.48 centimeters (cm)
1 inch (in)	=	2.54 centimeters (cm) exactly

Mass

- Measure of the amount of matter present in an object.
- SI unit = kilogram (kg)
  - ✓ About 2 lbs. 3 oz.
- Commonly measure mass in grams (g) or milligrams (mg).
  - ✓ 1 kg = 2.2046 pounds, 1 lbs. = 453.59 g
  - ✓ 1 kg = 1000 g = 10^3 g,
  - ✓ 1 g = 1000 mg = 10^3 mg
  - ✓ 1 g = 0.001 kg = 10^{-3} kg,
  - ✓ 1 mg = 0.001 g = 10^{-3} g

Time

- measure of the duration of an event
- SI units = second (s)
- other units of measurements are minutes, hours, days etc.
  - ✓1 min = 60 s
  - ✓1 hour = 60 mins
  - ✓1 day = 24 hours

Temperature

- measure of the average amount of kinetic energy
  - ✓ i.e., temperature tells you how hot or cold matter is

- SI units = Kelvin (K)
  - ✓ Other units include degrees Celsius (°C) and degrees Fahrenheit (°F)

The Celsius Temperature Scale

0 °C – Water freezes | 10 °C – Brisk fall day | 22 °C – Room temperature | 40 °C – Summer day in Death Valley

Prefix Multipliers

Think of the measurements

a) 10 m

b) 0.1m

c) 1 000 000 000 000 000 000 m

d) 0.000 000 000 000 001 m

It is easier to handle the measurements of (a) and (b), however, when the values become very large or very small such as in cases (c) and (d) respectively, it becomes challenging. We can then use prefix multipliers in such cases

Prefixes Multipliers are used to express very large or very small quantities. (*see complete table in P23 of text book*)

Common Prefix Multipliers in the SI System

Prefix	Symbol	Multiplier	
kilo-	k	1,000	10^{3}
mega-	M	1,000,000	10^{6}
giga	G	1,000,000,000	10^{9}
deci-	d	0.1	10^{-1}
centi-	c	0.01	10^{-2}
milli-	m	0.001	10^{-3}
micro-	μ	0.000 001	10^{-6}
nano-	n	0.000 000 001	10^{-9}

Example

Express the following distances in meters (m)

a) 1 kilometer (or 1km)

b) 50 kilometers (or 50 km)

Solution

a) 1 kilometer = ?

1 kilometer = 1000 meters = 10^3 meters

1 km = 1000 m = 10^3 m

b) 50 kilometers = ?

50 kilometer = 50 x 1000 meters = 50,000 meters

50 km = 50 x 1000 m = 50,000 m

Example

Express the following in grams (g)

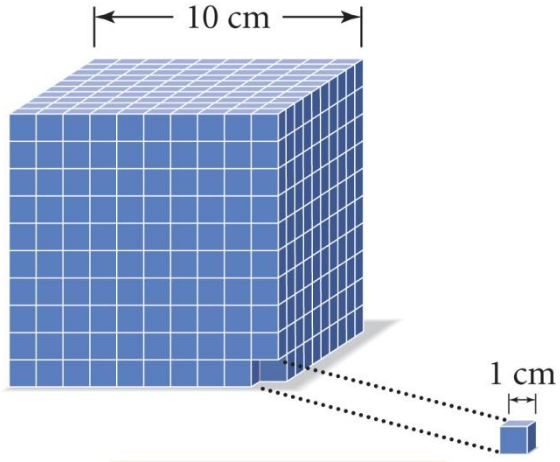
a) 1 mg = 0.001g

b) 700 mg = 700 x 0.001 g = 0.7 g

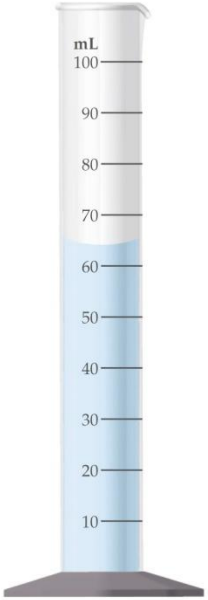
c) 16.2 kg = 16.2 x 1000 g = 16,200 g

Volume

- Measure of the amount of space occupied.
- SI unit = cubic meter (m^3)
- Commonly measure solid volume in cubic centimeters (cm^3).
  - ✓ $1\ m^3 = 10^6\ cm^3$
  - ✓ $1\ cm^3 = 10^{-6}\ m^3 = 0.000001\ m^3$
- Commonly measure liquid or gas volume in milliliters (mL).
  - ✓ 1 L is slightly larger than 1 quart.
  - ✓ $1\ L = 1\ dm^3 = 1000\ mL = 10^3\ mL$
  - ✓ $1\ mL = 0.001\ L = 10^{-3}\ L$
  - ✓ $1\ mL = 1\ cm^3$



A 10-cm cube contains 1000 1-cm cubes.



Solving Chemical Problems

- Conversion Factors (dimensional analysis)
- Equations

Conversion Factors

- Conversion factor is based on the relationship between 2 units
- For every relationship, we can write 2 different conversion factors

Examples:

a) For 1 m = 100 cm

The conversion factors are $\frac{\textbf{1m}}{\textbf{100cm}}$ OR $\frac{\textbf{100cm}}{\textbf{1m}}$

b) For 1 L = 1000 mL

The conversion factors are $\frac{\textbf{1L}}{\textbf{1000mL}}$ **OR** $\frac{\textbf{1000 mL}}{\textbf{1L}}$

Conversion Factors

- Sometimes the conversion factor may not be straight forward

Examples: Write down the conversion factors in the following cases

c) The maximum speed that Chevy-Cobalt can run is 160 miles per hour

The conversion factors are $\frac{\textbf{160 miles}}{\textbf{1 hour}}$ OR $\frac{\textbf{1 hour}}{\textbf{1 60 miles}}$

d) The density of gold is 19.3 g/cm^3

The conversion factors are $\frac{\textbf{19.3 g}}{\textbf{1cm}^3}$ **OR** $\frac{\textbf{1cm}^3}{\textbf{19.3 g}}$

Problem Solving by use of Conversion Factors

Example : Convert 0.32 m to cm.

<u>Solution:</u>

Plan: m → cm

Relationship: **1m = 100 cm**

Conversion factors are: $\dfrac{\mathbf{1m}}{\mathbf{100cm}}$ OR $\dfrac{\mathbf{100cm}}{\mathbf{1m}}$

Therefore: $\mathbf{0.32\ \cancel{m}\ x}\ \dfrac{\mathbf{100\ cm}}{\mathbf{1\ \cancel{m}}}$ = <u>32 cm</u>

Problem Solving by use of Conversion Factors

In some cases we may need more than one conversion factors

Example : Convert 30.0 mL to quarts

Solution

Plan: mL $\longrightarrow$ L $\longrightarrow$ qt

Relationship: **1 L = 1.057 qt**

0.001 L = 1 mL

Therefore: $$30.0\,\text{mL} \times \frac{0.001\,\text{L}}{1\,\text{mL}} \times \frac{1.057\,\text{qt}}{1\,\text{L}} = 0.03171\,\text{qt}$$ **= <u>0.0317 qt</u>**

Example 2.8—Convert 7.8 km to Miles

1. Write down the **Given** quantity and its unit.	**Given:**	7.8 km 2 significant figures
2. Write down the quantity you want to **Find** and unit.	**Find:**	? miles
3. Write down the appropriate **Conversion Factors**.	**Conversion Factor:**	1 km = 0.6214 mi
4. Write a **Solution Map**.	**Solution Map:**	km → mi $\frac{0.6214\ \text{mi}}{1\ \text{km}}$
5. Follow the solution map to **Solve** the problem.	**Solution:**	$7.8\ \cancel{\text{km}} \times \frac{0.6214\ \text{mi}}{1\ \cancel{\text{km}}} = 4.84692\ \text{mi}$
6. Significant figures and round.	**Round:**	4.**8**4692 mi = 4.8 mi 2 significant figures
7. Check.	**Check:**	Units and magnitude are correct.

Practice 1—Convert 30.0 g to Ounces

(1 oz. = 28.32 g)

Practice 2—Convert 30.0 Quarts to mL

(1 mL = 0.001 L; 1 L = 1.057 qts)

Density

- Ratio of mass:volume.

$$Density = \frac{Mass}{Volume}$$

- Solids = g/cm^3
- Liquids = g/mL
- Gases = g/L
- Density : solids > liquids > gases

Density, Continued

- For equal volumes, the more dense object has a larger mass.
- For equal masses, the more dense object has a smaller volume.
- Heating objects causes them to expand.
  - ✓This does not effect their mass!
  - ✓How would heating an object effect its density?
- In a heterogeneous mixture, the more dense object sinks.
  - ✓Why do hot air balloons rise?

Using Density in Calculations

Solution Maps:

$$\textbf{Density} = \frac{\textbf{Mass}}{\textbf{Volume}}$$

m, V → D

$$\textbf{Volume} = \frac{\textbf{Mass}}{\textbf{Density}}$$

m, D → V

$$\textbf{Mass} = \textbf{Density} \times \textbf{Volume}$$

V, D → m

Example

Platinum has become a popular metal for fine jewelry. A man gives a woman an engagement ring and tells her that it is made of platinum. Noting that the ring felt a little light, the woman decides to perform a test to determine the ring's density before giving him an answer about marriage. She places the ring on a balance and finds it has a mass of 5.84 grams. She then finds that the ring displaces 0.556 cm^3 of water. Is the ring made of platinum? (Density Pt = 21.4 g/cm^3)

She places the ring on a balance and finds it has a mass of 5.84 grams. She then finds that the ring displaces 0.556 cm^3 of water. Is the ring made of platinum? (Density Pt = 21.4 g/cm^3)

Given: Mass = 5.84 grams

Volume = 0.556 cm^3

Find: Density in grams/cm^3

Equation:

$$\frac{m}{V} = d$$

Solution Map:

m* and *V* → *d

m, V → d

$$\frac{m}{V} = d$$

She places the ring on a balance and finds it has a mass of 5.84 grams. She then finds that the ring displaces 0.556 cm^3 of water. Is the ring made of platinum? (Density Pt = 21.4 g/cm^3)

Apply the Solution Map:

$$\frac{m}{V} = d$$

m, V → d

$$\frac{m}{V} = d$$

$$\frac{5.84\,\text{g}}{0.556\,\text{cm}^3} = 10.5\,\text{g}/\text{cm}^3$$

Since 10.5 g/cm^3 $\neq$ 21.4 g/cm^3, the ring cannot be platinum.

Density as a Conversion Factor

- Can use density as a conversion factor between mass and volume!
  - ✓Density of H_2O = 1 g/mL ∴ 1 g H_2O = 1 mL H_2O
  - ✓Density of Pb = 11.3 g/cm^3 ∴ 11.3 g Pb = 1 cm^3 Pb
- How much does 4.0 cm^3 of lead weigh?

$$4.0\ \cancel{cm^3\ Pb} \times \frac{\mathbf{11.3\ g\ Pb}}{\mathbf{1\ \cancel{cm^3\ Pb}}} = 45\ g\ Pb$$

Measurement and Problem Solving: Density as a Conversion Factor

- The gasoline in an automobile gas tank has a mass of 60.0 kg and a density of 0.752 g/cm^3. What is the volume in cm^3?
- Given: 60.0 kg
- Find: Volume in cm^3
- Conversion factors:
  - ✓ 0.752 g/cm^3
  - ✓ 1000 grams = 1 kg

Solution Map:

kg → g → cm^3

$$\frac{1000\ \text{g}}{1\ \text{kg}} \qquad \frac{1\ \text{cm}^3}{0.752\ \text{g}}$$

Measurement and Problem Solving: Density as a Conversion Factor, Continued

Solution Map:

kg → g → cm^3

$$\frac{1000\text{ g}}{1\text{ kg}} \qquad \frac{1\text{ cm}^3}{0.752\text{ g}}$$

$$60.0\text{ kg} \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1\text{ cm}^3}{0.752\text{ g}} = 7.98 \times 10^4\text{ cm}^3$$

Practice—What Volume Does 100.0 g of Marble Occupy? (d = 4.00 g/cm^3)

Home WorK:

- A 55.9 kg person displaces 57.2 L of water when submerged in a water tank. What is the density of the person in g/cm^3?

Recommended Study Problems Chapter 2

NB: *Study problems are used to check the student's understanding of the lecture material. Students are* ***EXPECTED TO BE ABLE TO SOLVE ALL THE SUGGESTED STUDY PROBLEMS***.

If you encounter any problems, please talk to your professor or seek help at the HACC-Gettysburg/York learning center.

Questions from text book Chapter 2, p 42

4, 5, 6, 9, 11, 21-26, 29-33, 35,37, 39, 41-47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 71, 73, 77, 79, 81, 83, 85, 89, 91, 93, 95, 97-100, 103, 109, 111-114

ANSWERS

-The answers to the **odd-numbered** study problems are found at the back of your textbook