Unit Two: Scientific Measurements

Learning Targets:	Textbook Section:
2.1) Write numbers in scientific notation.	3.1
2.2) Evaluate accuracy and precision.	3.1
2.3) Explain why measurements must be reported to the correct number of significant figures.	3.1
2.4) Explain why metric units are easy to use.	3.2
2.5) Identify the temperature units scientists commonly use.	3.2
2.6) Calculate the density of a substance.	3.2
2.7) Explain what happens when a measurement is multiplied by a conversion factor.	3.3
2.8) Describe the kinds of problems that can be easily solved using dimensional analysis.	3.3

Suggested Reading:
Chapter 3: Pages 60-94

End of Chapter Practice:
56, 57, 58, 59, 61, 62, 65, 66, 67, 68, 69, 73, 74, 75, 77, 78, 79, 80, 82, 84, 86, 87, 88, 89, 90, 91, 96, 102

Unit Two: Scientific Measurement

What is a measurement?
a quantity that has both a number and unit.
- height (66 inches) - age (15 years)

It is important to be able to make measurements and to decided whether a measurement is correct. In chemistry, you will often encounter very large or very small numbers.

1g of hydrogen = 602,000,000,000,000,000,000,000 hydrogen atoms
1 atom of gold = 0.000000000000000000000327 grams

As scientists we use Scientific Notation to make working with these large and small numbers more manageable.

Scientific Notation:

The coefficient is always a number greater than or equal to one and less than ten.
The exponent is an integer. 5.0×10^{-3} ← Exponent; 5.0 = Coefficient

In scientific notation, the coefficient is always a number greater than or equal to one and less than ten.

** a positive exponent indicates how many times the coefficient needs to be multiplied by ten.

** a negative exponent indicates how many times the coefficient needs to be divided by ten.

Writing Scientific Notation:

When writing numbers greater than ten in scientific notation, the exponent is positive and equals the number of places that the original decimal point has been moved to the left.

6,300,00 6.3×10^5

94,700 9.47×10^4

Numbers less than one have a negative exponent when written in scientific notation. The value of the exponent equals the number of places the decimal has been moved to the right.

0.000008 8.0×10^{-6}

0.00736 7.36×10^{-3}

* Always use parentheses when plugging numbers in your calculator!

Significant Figures:

In any measurement there are digits that we know for certain and then there is one digit that we estimate- this is known as the uncertain digit.

Temperature reading 22.9°F

The first two digits (2,2) are known with Certainty

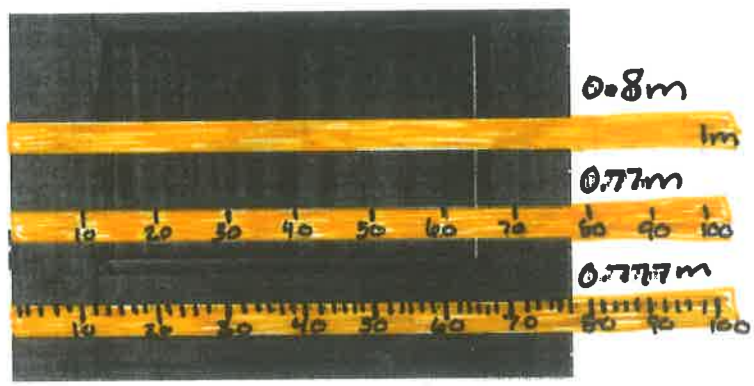
The last digit (9) involves some uncertainty

These reported digits all convey useful information and are called

Significant Figures. (Sig Figs)

Measurements must always be reported to the correct number of significant figures because calculated answers often depend on the number of significant figures in the values used in the calculation.

**instruments differ in the number of significant figures that can be obtained from their use and thus in the precision of measurements.



How to Determine Significant Figures:

*pg 67 in your book lists these as well with other examples.

1) All non-zero digits are significant figures.

24.7 m   0.743 m   714 m

2) zeroes between non-zero digits are significant.

105   3,000,005   0.3009   15,004

3) zeroes that "prop" other numbers away from the decimal are non-significant placeholders.

1000   0.092   0.0001   0.42

4) Zeros to the right of a decimal digit are sig figs.

32.0   0.00010   0.53000   43.000

5) "Counting numbers" are sig figs   23 people   60 mins = 1 hr

Suppose you use a calculator to find the area of a floor that measures 7.7 meters by 5.4 meters. The calculator would give an answer of 41.58 square meters. However, each measurement used in the calculation is expressed to only two significant figures.

What should the answer be using the proper numbers of significant figures?

7.7 = 2 S.F.
5.4 = 2 S.F.

~~41.6~~ m^2 → 42 m^2

Practice:

Determine how many significant figures are in each measurement.

A. 123 m — 3

B. 40,056 mm — 5

C. 9.8000×10^4 m — 5

D. 22 meter sticks — 2

E. 0.07080 m — 4

F. 98,000 m — 2

G. 0.05730 m — 4

H. 8765 m — 4

I. 0.00073 m — 2

J. 40.007 meters — 5

K. 143 g — 3

L. 0.074 m — 2

M. 8.750×10^{-2} m — 4

N. 1.072 mL — 4

Density:

The density of an object show the relationship between an object's mass and its volume.

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} \qquad d = \frac{m}{V}$$

Density is an intensive property that depends only on the composition of a substance, not on the size of the sample.

Density is usually expressed in units of grams per milliliter (g/mL). or g/cm^3

**Osmium, a blue/white metal, is the densest substance on Earth! A football sized piece is too heavy to lift.

We can use the density of an object to determine if it will float or sink:

Float:
object has a lower density than the substance it is in.

Sink:
Object has a higher density than the substance it is in.

Practice:

1) A copper penny has a mass of 3.1 g and a volume of 0.35 cm³. What is the density of the copper?

$d = \frac{m}{V}$ $\quad d = \frac{3.1g}{0.35 cm^3} = 8.85714 \; g/cm^3$

density of the penny $= 8.9 \; g/cm^3$

2) A bar of silver has a mass of 68.0g and a volume of 6.48 cm³. What is the density of silver?

$d = \frac{m}{V}$ $\quad \frac{68.0g}{6.48cm^3} = 10.4938 \; g/cm^3$

density of Silver bar $= 10.5 \; g/cm^3$

3) A student finds a shiny piece of metal that she thinks is aluminum. In the lab, she determines that the metal has a volume of 245 cm³ and a mass of 612g. Calculate the density. Is the metal aluminum? (Actual density of aluminum = 2.70 g/cm³).

$V = 245 \; cm^3$
$m = 612 \; g$
$d = ?$

$d = \frac{612g}{245 cm^3}$ $\quad d = 2.4979 \; g/cm^3$

density of metal $= 2.50 \; g/cm^3$

→ No, it is not Aluminum.