CHM 101 GENERAL CHEMISTRY

FALL QUARTER 2008

Section 2

Lecture Notes – 9/24/2008

(last revised: 9/30/08)

1.1 Overview

- Macroscopic World: Matter appears to be continuous but infinitely divisible.
- Microscopic World: Matter consists of individual atoms (from the Greek meaning *indivisible*).
- Kinds of Atoms: Relatively few different kinds (100 or so), sort of like letters in an alphabet.
- Kinds of Substances: A huge number, made of combinations of atoms, sort of like the words in a language.
- Molecules: More-or-less simple combinations of atoms, example: water (H_2O).
- Molecular vs. Macroscopic Scales: One ounce of water consists of approximately 10^{24} water molecules.

1.2 Scientific Method

- Steps in the Scientific Method:
    - 1) Make observations, either *qualitative* (without numbers), or *quantitative* (a number and a unit).
        - Qualitative: “The top of the lecture bench is solid.”
        - Quantitative: “The boiling point of water in South Lake Tahoe is 93 °C.”
    - 2) Formulate hypotheses (possible explanations of the observations).
    - 3) Design and perform experiments to test the hypotheses.

    - 1a) Observe the results (sort of like step 1).
    - 2a) Refine the hypotheses.
    - 3a) Design and perform additional experiments, etc.
- Scientific Models:
    - 1) Formulate a model (also called a theory) from a consistent set of observations and hypotheses.
    - 2) Use the model to predict the outcome of a new experiment.
    - 3) Perform the experiment, comparing the result vs. the prediction.
    - 1a) Reformulate the model to reconcile any differences.
    - 2a) More predictions.
    - 3a) More experiments.
    - 1b) More reformulation of the model, etc.
- Theory vs. Natural Law
    - Natural Law summarizes behavior (Newton's Law of Gravity, Einstein's Law of Relativity)
- Theory explains observations (Darwin's Theory of Evolution)

1.3 Units of Measurement

- A measurement must have both a number and a scale (or unit). For example: a particular measurement might be 50.2 ml.
- We also need an object. (What is it that we are measuring?) A measurement of 50.2 ml is not very meaningful, unless we stipulate, for example, that it is 50.2 ml of distilled water, or that it is 50.2 ml of concentrated sulfuric acid.
- Fundamental Physical Quantities
    - Mass
    - Length

- Time
- Temperature
- Electric Current
- Amount of Substance
- Luminous Intensity

- Other quantities, such as Volume, Energy, and Pressure are derived from the fundamental quantities.

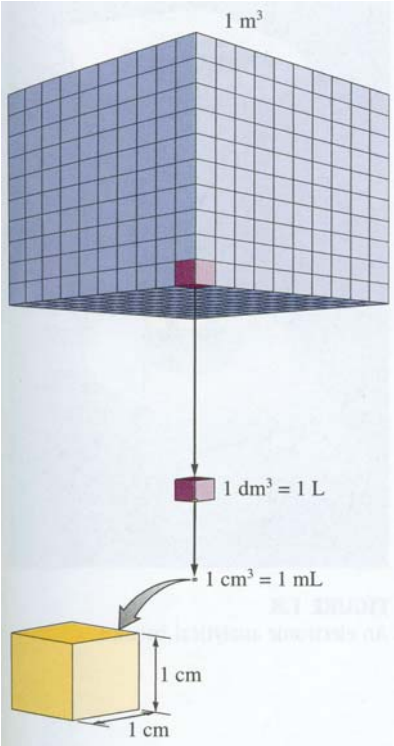

FIGURE 1.6
The largest cube has sides 1 m in length and a volume of 1 m^3. The middle-sized cube has sides 1 dm in length and a volume of 1 dm^3, or 1 L. The smallest cube has sides 1 cm in length and a volume of 1 cm^3, or 1 mL.

- Systems of Units
  - English (pounds, feet, seconds, degrees Fahrenheit)
  - SI (Système International) (kilograms, meters, seconds, Kelvins)

TABLE 1.1 The Fundamental SI Units

Physical Quantity	Name of Unit	Abbreviation
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	cd

- We will use only SI in General Chemistry.
- Prefixes: Just as an inch is a small unit of distance and a mile is a large unit of distance in the English system, SI has ways to describe small and large numbers of its various quantities:

TABLE 1.2 The Prefixes Used in the SI System (Those most commonly encountered are shown in blue.)

Prefix	Symbol	Meaning	Exponential Notation*
exa	E	1,000,000,000,000,000,000	10^{18}
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
—	—	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}
atto	a	0.000000000000000001	10^{-18}

*See Appendix 1.1 if you need a review of exponential notation.

1.4 Uncertainty

- Uncertainty is a measure of how closely a measurement matches the “actual” value of the quantity being measured.
- Uncertainty depends on how closely the measuring device can allow an observer to differentiate between different quantities of what is being measured.

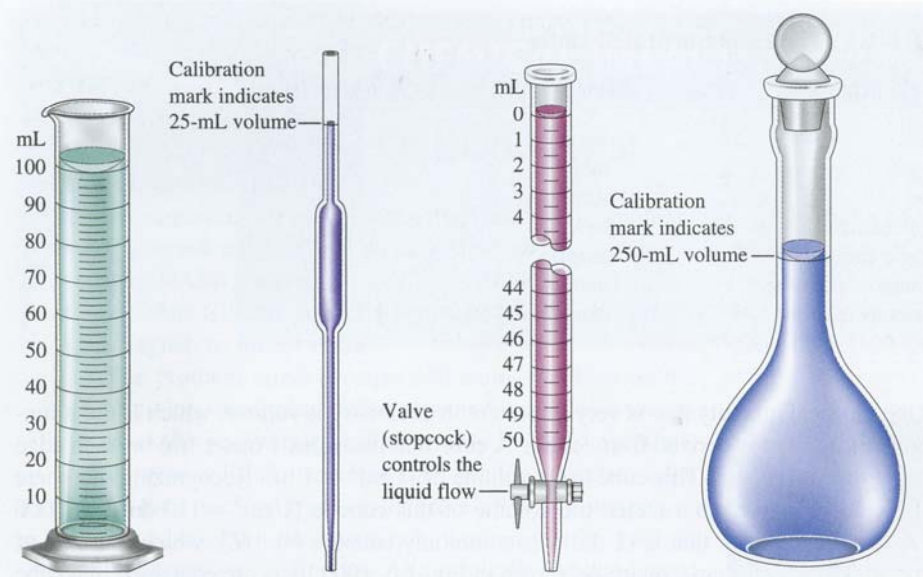

FIGURE 1.7
Common types of laboratory equipment used to measure liquid volume.

- Certain and Uncertain Digits

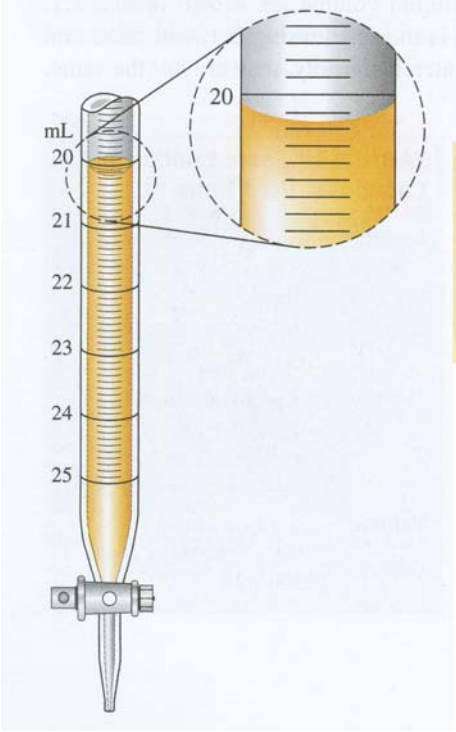

FIGURE 1.9
Measurement of volume using a buret. The volume is read at the bottom of the liquid curve (called the meniscus).

Person	Results of Measurement
1	20.15 mL
2	20.14 mL
3	20.16 mL
4	20.17 mL
5	20.16 mL

- Uncertainty and the Measuring Instrument

Bathroom Scale **Analytical Balance**

Grapefruit 1	1.5 lb	1.476 lb
Grapefruit 2	1.5 lb	1.518 lb

	Pipette	**Graduated Cylinder**
Water Sample	25.00 ml	25 ml

- Precision vs. Accuracy

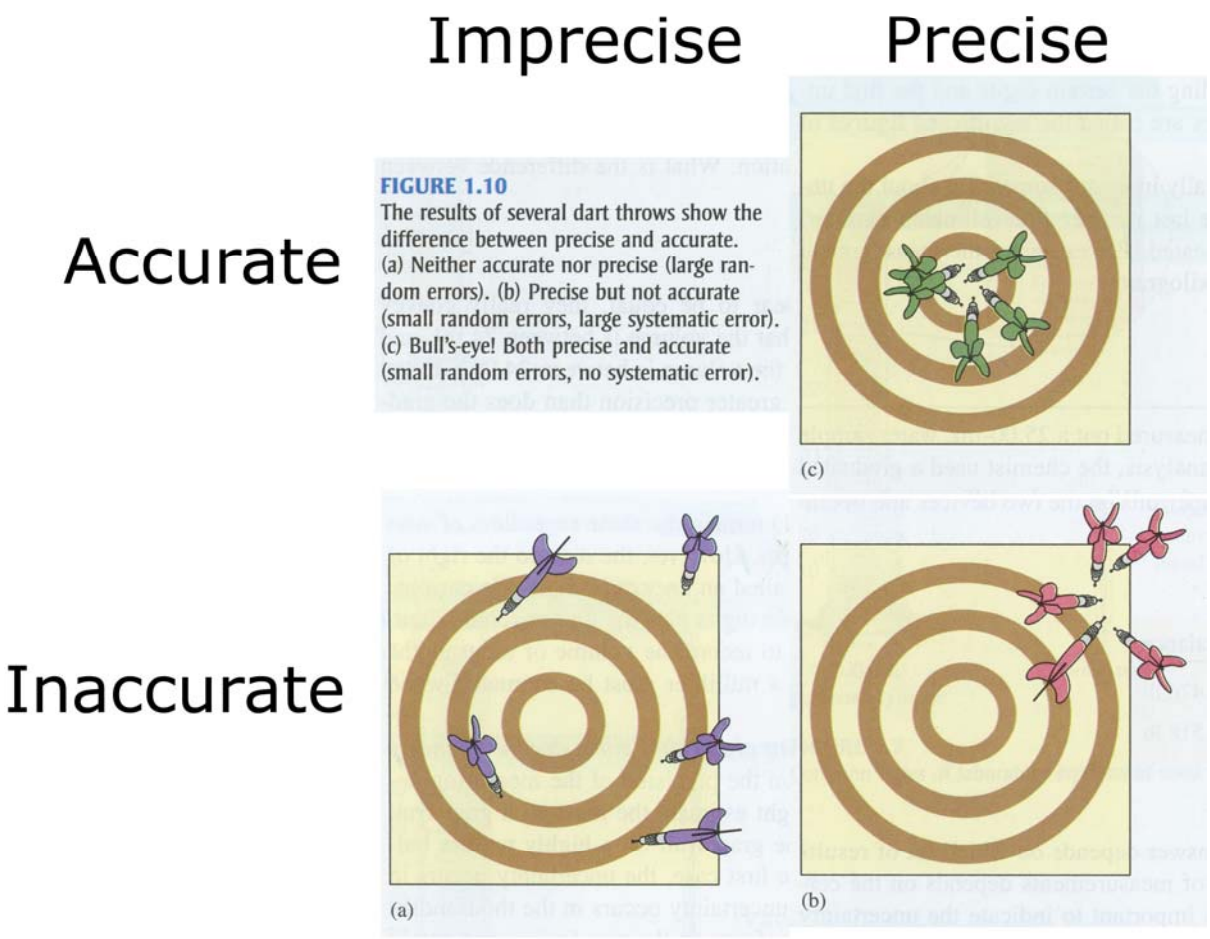

FIGURE 1.10
The results of several dart throws show the difference between precise and accurate. (a) Neither accurate nor precise (large random errors). (b) Precise but not accurate (small random errors, large systematic error). (c) Bull's-eye! Both precise and accurate (small random errors, no systematic error).