

Chapter 2: Measurement and Calculations

These Notes are to SUPPLIMENT the Text, They do NOT Replace reading the Text Material. Additional material that is in the Text will be on your tests! To get the most information, READ THE CHAPTER prior to the Lecture, bring in these lecture notes and make comments on these notes. These notes alone are NOT enough to pass any test!

The author is providing these notes as an addition to the students reading the text book and listening to the lecture. Although the author tries to keep errors to a minimum, the student is responsible for correcting any errors in these notes.

Measurement: A quantative observation

Example: A car that gets 20 miles per gallon will need 10 gallons of gas to travel 200 miles
It takes ten \$10 bills to exchange for one \$100 bill!

A number consists of a number and a unit. NEVER write out a number without it's units.

Scientific Notation: Product of a number between 1 and 9 and the appropriate power of 10

$$125 = 1.25 \times 100 = 1.25 \times 10^2$$

$$0.0125 = 1.25 \times 10^{-2}$$

The Powers of 10 can be Positive or Negative

Discuss Significant Digits All digits are significant except:

1. Zero's to the left of the first digit are NOT significant **000123.456**
2. Zero's to the right of the last digit ARE significant **123.456000**

Avogadro Number: 6.022×10^{23} **Do Some Examples – see my previous Ch 2 Tests and Quizzes**

General rules: Read each line value and then interpret between two lines.

Read a ruler

Read a Burette, Graduate Cylinder

Read a balance – digital display

Units are based on the system your using: **English, Metric, International / SI"**

Units:	<u>English</u>	<u>Metric</u>	<u>International / SI</u>
Mass	Pound - lb	Kilogram – kg	Kilogram – kg
Length	Foot/Inch – Ft/in	Meter – m	Meter – m
Volume	Quart – Qt	Liter – l	Liter - l
Time	second – sec	second – sec	second – sec
Temp	Fahrenheit – F	<i>Centigrade</i> – C	Kelvin – K

Multipliers:	Mega – M	1,000,000	10^6
	Kilo - k	1000	10^3
	deci - d	0.1	10^{-1}
	centi – c	0.01	10^{-2}
	milli - m	0.001	10^{-3}
	micro – mu	0.000,001	10^{-6}
	nano - n	0.000,000,001	10^{-9}

Measurements of Length Fundamental SI unit of length is METER = 39.37 inches

Kilometer	meter	decimeter	Centimeter	millimeter	micrometer	nanometer
1,000 m	1 m	0.1 m	0.01 m	0.001m	0.000,001 m	10^{-9} m

1" = 2.54 CENTIMETERS – Remember This Conversion!

Volume Amount of 3 dimensional space occupied by a substance

Volume of a cube 1.0 m on its side: $1.0 \text{ m} \times 1.0 \text{ m} \times 1.0 \text{ m} = 1.0 \text{ m}^3$

Convert 1.0 m^3 to ml: $1.0 \text{ m}^3 * \frac{1000 \text{ L}}{1.0 \text{ m}^3} = 1000 \text{ L}$ $1000 \text{ L} * \frac{1000 \text{ ml}}{1 \text{ L}} = 1,000,000 \text{ ml}$
= 1.0×10^6 ml

Mass Quantity of matter present in an object, Determine mass with a balance - discuss temp effects

1 Kilogram = 1000 gram, 1g = 1000 milligram

Uncertainty in Measurement The last number read is based on a visual estimate

Draw a ruler in CM, MM etc.

Basic Rules for Significant Digits:

1. Zeroes to the left of the first digit **do not count**
2. Zeroes to the right of the last digit **do count.**

Significant Figures

Numbers recorded in a measurement = all the certain numbers plus the FIRST uncertain number

1. Nonzero integers - All nonzero integers ALWAYS count e.g. 0012305.45600
2. Zero's:
 - A: Leading zeros that precede nonzero NEVER COUNT e.g. 0012305.45600
 - B: Captive zeros fall between nonzero ALWAYS COUNT e.g. 0012305.45600
 - C: Trailing zeros - right of a number COUNT if decimal e.g. 0012305.45600
3. Exact Numbers - not obtained from measuring device e.g. 1 dozen = 12.0000000

EXAMPLE PROBLEMS [How many sig figs are in each of the following?]

A	12.00	B	012.00	C	0.1200
D	0.1200	E	0.01200		
F	111.	G	111		
H	110.	I	110		

Significant Figures Determine number of significant figures in calculated result.

- Round Off**
1. Less than 5 - digit stays the same. e.g. 12.34 → 12.3
 2. Greater than or equal to 5 - digit is increased by 1 e.g. 12.35 → 12.4
 2. In a series of calculations - **carry all digits then round off**
e.g. 4.348 rounded to 2 digits is 4.3 [do not round the 4 to 5]

Significant Figures in Calculations

Rules for Multiplication / Division

Problem: 2.5 times 100.00 grams

Write out the values to multiply. Note the number of significant digits in each number.

The final answer must have the smallest of these two values in significant digits.

100.00 grams 5 significant digits
x 2.5 2 significant digits

250.00 grams [5 significant digits, but the answer must have 2 sd]

250 [2 or 3 significant digits, but the answer must have 2 sd]

250. [3 significant digits, but the answer must have 2 sd]

2.5 x 10² grams 2 significant digits answer, the only way you can do it is to use Scientific Notation

Rules for Addition / Subtraction:

Determine the molecular weight for H₂O

Draw a vertical line marking the least precise number value.

When you report the final result value, you do NOT report any values to the right of that line!

$$\begin{array}{r} 2 \text{ H} = 2 * 1.008 = 2.016 \\ 1 \text{ O} = 1 * 16.00 = \underline{16.00} \\ \hline 18.016 \end{array}$$

Line marks the least precise number

After you drop the 6 and round up
18.02 g/mole

SEE ” Chemistry Conversion Units” on my website “Extra Notes for all Classes”

Problem Solving Dimensional Analysis also known as Conversion Factors

Length:	2.54 cm	= 1 inch	How do you convert miles to km?
Mass	453.59 g	= 1 lb	How do you convert tons to milligrams?
Volume	1 liter	= 1.057 qt	How do you convert gallons to milliliters?

Dimensional Analysis Changing from one unit to another

<u>Temperature</u>	Kelvin	Centigrade	Fahrenheit
Water Boil	373.15	100	212
Water Freez	273.15	0	32
Absolute Zero	0	-273.15	"?"

Fahrenheit $F = (9/5 * C) + 32$

Celsius $C = (F - 32) * 5/9$
 $C = K - 273.15$

Kelvin $K = C + 273.15$

NOW WORK PROBLEMS!

Density Amount of matter present in a given volume
 $\text{Density} = \text{Mass [g]} / \text{Volume [ml]}$

Which is denser - a pound of lead or a pound of feathers?

Specific Gravity Ratio of den of liq to density of water at 4 deg C NO UNITS

Homework Problems:

What is the volume of a cube 23.0 cm by 1.5 ft by 16.0 m in cu yards and in ml?

Using density values, how can you measure out 53.0 ml of ethanol without using a graduate cylinder?

Book Problems

Problems: 35, 36 41, 42 51, 52, 63, 64, 66

Chapter 2, p45++

In-Class Discussion: 3, 13

Q&P: 9, 20, 23, 43, 47, 64, 79, 80, 93, 109, 133, 156

Common Mistakes:

1. Did not do the problems In-Class Discussion: 3 & 13
2. Did not show ALL MATH and ALL UNITS in determining an answer
3. Did not show the correct number of significant digits
4. As a comment – numbers in the thousands and millions, put in the comma: 1,234 1,234,567.0
5. As a comment – for readability with a decimal with a lot of zero's, put in a space every 3 zero's:
0.000 000 012345