

# Chem 111

## Lecture 3



# Announcements

- Supplementary Instructors
- Don't be afraid to ask questions

# Homework

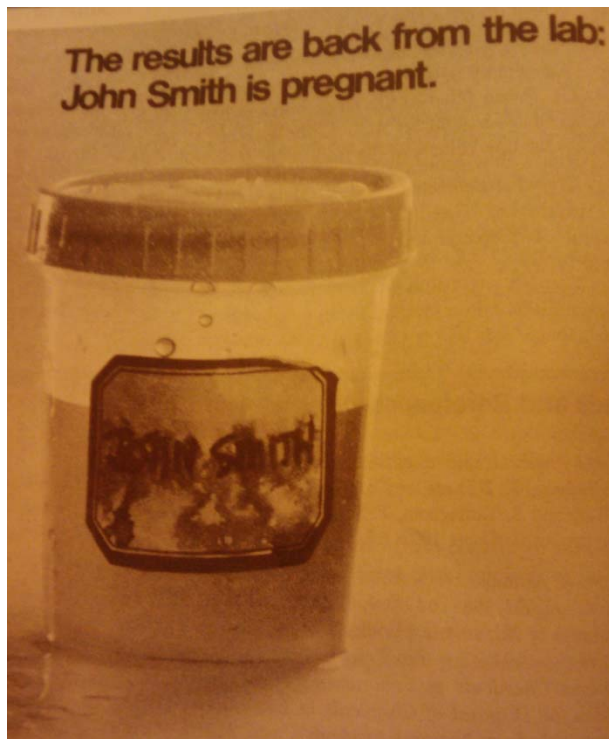
- Finish “Let’s Review”
- Start Reading Chapter 2
- OWL online homework.

# Recap

- Flow chart on classification of matter
- Physical and Chemical Properties
- Physical and Chemical Changes
- SI units and prefixes **\*\*Memorize\*\***
- Temperature – know conversions
- Precision V accuracy

# Error

$$\text{percent error} = \frac{\text{error in measurement}}{\text{accepted or 'true' value}} \times 100\%$$



## Standard Deviation

$$s = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{n - 1}}$$

measure value

avg

# measurements

# Scientific Notation

.00000102  
132000000

Sometimes called exponential notation, is a way of writing numbers that accommodates values too large or small to be conveniently written in decimal notation.

Expressed as a product:  $N \times 10^y$

$10 \nless N \ngtr 1$

$y = \text{integer}$

$y < 1, < 1$

Decimal: 1207000000

$1.207 \times 10^3 \rightarrow 1.207 \times 10^9$

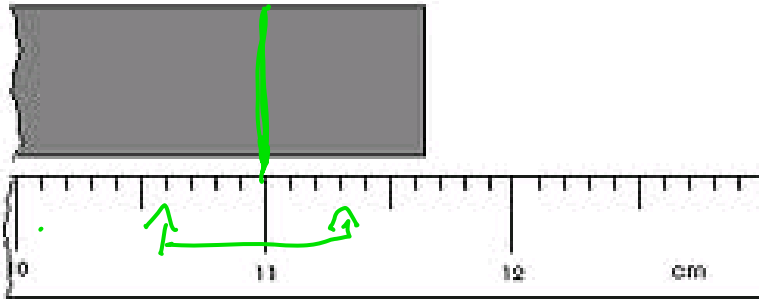
SN:  $3.6 \times 10^5$

$3.6 \times 10^5 \rightarrow 3.6 \times 10 \times 10^5$

Calculators, Excel, OWL, Computer etc... **PAGE 34**

# Significant Figures

Indicates the exactness of a measurement



11.62

11.623598654

11.0

11

The number of digits that can be justified by the data.

# Guidelines

- Nonzero = significant. 963, 2.9
- Zeros between nonzeros = significant. 1006, 1.03
- Leading zeros not significant. 0.002, 0046
- Trailing zeros after decimal = significant 3.0, 0.0200
- Trailing zeros with no decimal are ambiguous → use scientific notation

406.  
 $4 \times 10^2$   
 $4.0 \times 10^2$

$2.00 \times 10^{-2}$

- Exact numbers have infinite significant figures.

$4.00 \times 10^2$

12 inches = 1 ft  
 12.000000



# Sig Figs In Calculations

The precision of the result is the precision of the measurement.

**Adding/Subtracting** – the result cannot have more digits to the right of the decimal point than any of the original number.

**Fewest Decimal Places**

$$\begin{array}{r} 92.1 \\ 1.209 \\ 45 \\ \hline 138.309 \end{array}$$

Handwritten notes in green:

- ← 1 decimal (pointing to 92.1)
- ← 3 decimal (pointing to 1.209)
- ← 0 decimal (pointing to 45)

The result 138.309 is circled in red, and the underline is crossed out with a red line.

# Sig. Figs. In Calculations

The precision of the result is the precision of the measurement.

**Dividing/Multiplying** – the result must be reported with the same number of significant figures as the measurement with the fewest significant figures.

**Fewest Significant Figures.**

$$\begin{array}{r} 7.273 \quad \leftarrow 4 \\ 1.20 \quad \leftarrow 3 \\ \times 1.5124421 \quad \leftarrow 8 \\ \hline 13.19998967196 \rightarrow 13.2 \end{array}$$

# Dimensional Analysis

**Conversion Factor** is a fraction whose numerator and denominator are the same quantity expressed in different units.

$$2.54 \text{ cm} = 1 \text{ in.}$$

$$\frac{2.54 \text{ cm}}{1 \text{ in.}} = \frac{1 \text{ in.}}{2.54 \text{ cm}} = 1$$

$$\text{given unit} \times \frac{\text{desired unit}}{\text{given unit}} = \text{desired unit}$$

Length in inches of an 8.00m rod?

$$100 \text{ cm} = 1 \text{ m}$$

$$\frac{8.00 \text{ m}}{1} \left( \frac{100 \text{ cm}}{1 \text{ m}} \right) \left( \frac{1 \text{ in.}}{2.54 \text{ cm}} \right) = 315 \text{ in}$$

# Atomic Structure

**Atoms** are the basic building blocks of matter. They are the smallest particles of an element that retains the chemical identity of the element.

**TABLE 2.1** Properties of Subatomic Particles\*

Particle	Mass		Charge	Symbol
	<i>Grams</i>	<i>Atomic Mass Units</i>		
Electron ✓	$9.109383 \times 10^{-28}$	0.0005485799	1-	${}^0_{-1}\text{e}$ or $\text{e}^-$
Proton ✓	$1.672622 \times 10^{-24}$	1.007276	1+	${}^1_1\text{p}$ or $\text{p}^+$
Neutron ✓	$1.674927 \times 10^{-24}$	1.008665	0	${}^1_0\text{n}$ or $\text{n}$

\* These values and others in the book are taken from the National Institute of Standards and Technology website at <http://physics.nist.gov/cuu/Constants/index.html>

# Atomic Structure

**Atomic mass unit (u)** <sup>amu</sup> is one twelfth of the mass of an atom of carbon with six protons and six neutrons.  <sup>$^{12}\text{C}$</sup>

**TABLE 2.1** Properties of Subatomic Particles\*

Particle	Mass	
	Grams	Atomic Mass Units
Electron	$9.109383 \times 10^{-28}$	0.0005485799
Proton	$1.672622 \times 10^{-24}$	1.007276
Neutron	$1.674927 \times 10^{-24}$	1.008665

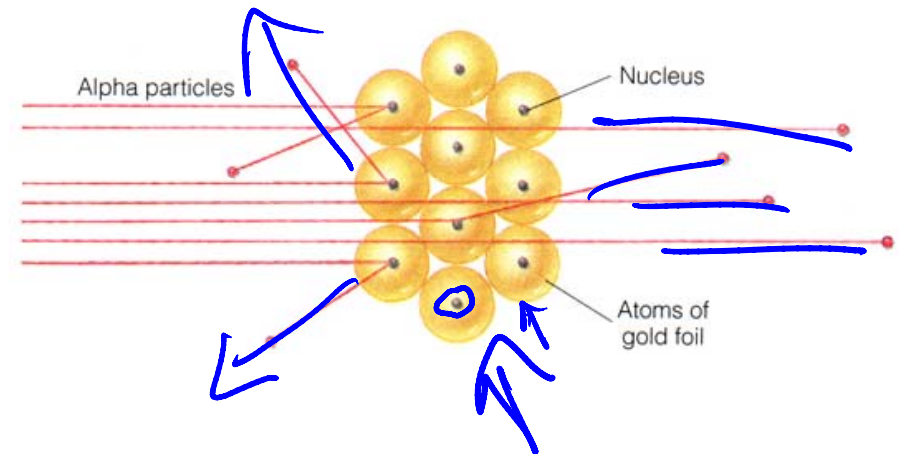
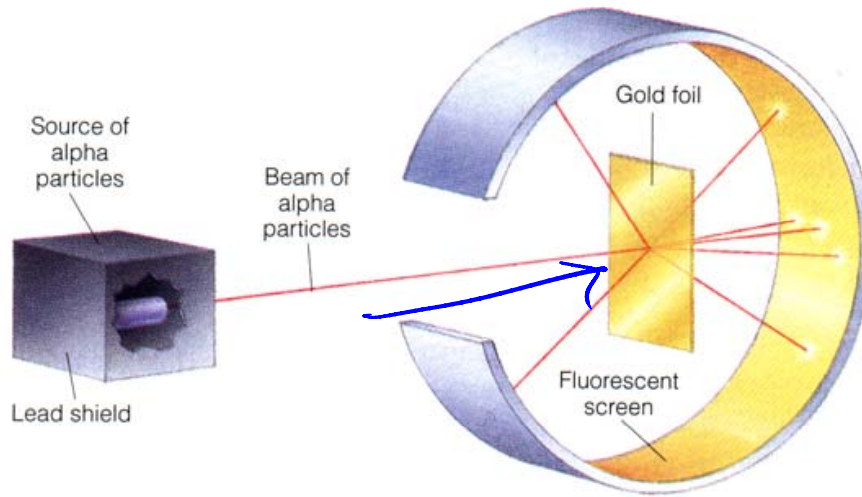
\* These values and others in the book are taken from the National Technology website at <http://physics.nist.gov/cuu/Constants/index.html>

A proton is about 1836 times more massive than an electron.

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$$\frac{0.000548 \dots}{1.007 \dots}$$

# Atomic Structure



## Sizes

**Nucleus:** 2 – 7 fm

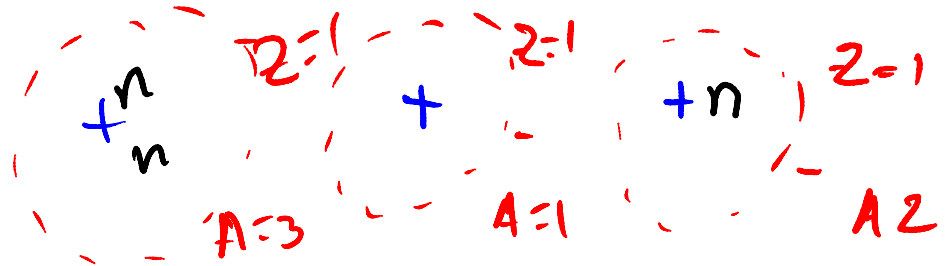
**Atom:** 30 – 300 pm

$\times 10^{-15} \text{ m}$   
 $\times 10^{-12} \text{ m}$

Imagine nucleus the size of a golf ball – 1.68 inches

$$\left( \frac{30 \times 10^{-12} \text{ m atom size}}{2.0 \times 10^{-15} \text{ m nucleus size}} \right) \left( \frac{1.68 \text{ in. nucleus}}{12 \text{ in.}} \right) \left( \frac{1 \text{ ft}}{12 \text{ in.}} \right) = 2100 \text{ ft atomic size}$$

# Atomic Structure



All atoms of an element have the same number of protons in the nucleus.

Elements are distinguished from one another by the number of protons or **Atomic Number (Z)**.

**Isotopes** are atoms of a given element that differ in the number of neutrons (and mass).

**Mass Number (A)**, is the total number of protons plus neutrons

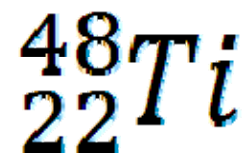
# Symbolic Representation

Mass Number

$\begin{matrix} A \\ Z \end{matrix} E$

Symbol for the element

Atomic Number



ATOMIC  
NUMBER

ATOMIC  
WEIGHT

22

47.90

Ti

SYMBOL

(Ar)3d<sup>2</sup>4s<sup>2</sup>

ELECTRON  
CONFIGURATION

Titanium

NAME





# Abundance

$$\text{percent abundance} = \frac{\text{\# of atoms in a given isotope}}{\text{total \# of atoms of all isotopes}} \times 100\%$$

**Atomic weight** - is the weighted average mass

*atomic weight*

$$\begin{aligned} &= \left( \frac{\% \text{ abundance isotope 1}}{100} \right) (\text{mass of isotope 1}) \\ &+ \left( \frac{\% \text{ abundance isotope 2}}{100} \right) (\text{mass of isotope 2}) + \dots \end{aligned}$$

# Periodic Table

Group 12131415161718																	
Periodic Table of Elements																	
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Period																	
s-blockd-blockp-block																	
f-block																	
Lanthanide Series																	
Actinide Series																	



# Periodic Table

A 3D periodic table with elements represented as colored blocks. The table is organized into three main regions: Metals (green blocks, covering the left and center), Nonmetals (orange blocks, covering the top right), and Metalloids (purple blocks, forming a diagonal line between metals and nonmetals). The table is labeled with numbers 1 through 18, representing the atomic number of the elements. The layout shows the first two rows of the periodic table, with the Lanthanide and Actinide series shown as separate rows below the main body.

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1	2																
2																		
3																		
4																		
5																		
6																		
7																		

**Metals** – luster, high electrical and thermal conductivity, ductile and malleable.

**Nonmetals** – various colors, brittle, poor conductors, low mp

**Metalloids** – Have properties that fall in between those of metals and nonmetals

# Periodic Table

Group 12131415161718																		
IA																VIIIA		
1	<b>H</b>																2	
2	<b>Li</b>	<b>Be</b>															<b>He</b>	
3	<b>Na</b>	<b>Mg</b>											<b>B</b>	<b>C</b>	<b>N</b>	<b>O</b>	<b>F</b>	<b>Ne</b>
4	<b>K</b>	<b>Ca</b>	<b>Sc</b>	<b>Ti</b>	<b>V</b>	<b>Cr</b>	<b>Mn</b>	<b>Fe</b>	<b>Co</b>	<b>Ni</b>	<b>Cu</b>	<b>Zn</b>	<b>Ga</b>	<b>Ge</b>	<b>As</b>	<b>Se</b>	<b>Br</b>	<b>Kr</b>
5	<b>Rb</b>	<b>Sr</b>	<b>Y</b>	<b>Zr</b>	<b>Nb</b>	<b>Mo</b>	<b>Tc</b>	<b>Ru</b>	<b>Rh</b>	<b>Pd</b>	<b>Ag</b>	<b>Cd</b>	<b>In</b>	<b>Sn</b>	<b>Sb</b>	<b>Te</b>	<b>I</b>	<b>Xe</b>
6	<b>Cs</b>	<b>Ba</b>	*	<b>Hf</b>	<b>Ta</b>	<b>W</b>	<b>Re</b>	<b>Os</b>	<b>Ir</b>	<b>Pt</b>	<b>Au</b>	<b>Hg</b>	<b>Tl</b>	<b>Pb</b>	<b>Bi</b>	<b>Po</b>	<b>At</b>	<b>Rn</b>
7	<b>Fr</b>	<b>Ra</b>	+	<b>Rf</b>	<b>Ha</b>	<b>Sg</b>	<b>Bh</b>	<b>Hs</b>	<b>Mt</b>	<b>Ds</b>	<b>Rg</b>	<b>Uub</b>	<b>Uut</b>	<b>Uuq</b>	<b>Uup</b>	<b>Uuh</b>	<b>Uus</b>	<b>Uuo</b>
<i>s-block</i>		<i>d-block</i>										<i>p-block</i>						
<i>f-block</i>	Lanthanide Series		57 * <b>La</b>	58 <b>Ce</b>	59 <b>Pr</b>	60 <b>Nd</b>	61 <b>Pm</b>	62 <b>Sm</b>	63 <b>Eu</b>	64 <b>Gd</b>	65 <b>Tb</b>	66 <b>Dy</b>	67 <b>Ho</b>	68 <b>Er</b>	69 <b>Tm</b>	70 <b>Yb</b>	71 <b>Lu</b>	
	Actinide Series		89 + <b>Ac</b>	90 <b>Th</b>	91 <b>Pa</b>	92 <b>U</b>	93 <b>Np</b>	94 <b>Pu</b>	95 <b>Am</b>	96 <b>Cm</b>	97 <b>Bk</b>	98 <b>Cf</b>	99 <b>Es</b>	100 <b>Fm</b>	101 <b>Md</b>	102 <b>No</b>	103 <b>Lr</b>	

Periodic Table of Elements

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Alkali Metals



Alkali Earth Metals





# Periodic Table

Group 12131415161718																																
IA		Periodic Table of Elements																VIIIA														
1	1	H																	2													
2	3	Li	4	Be																	10											
3	11	Na	12	Mg	IIIB	IVB	VB	VIB	VIIIB	IB		IIB	5	6	7	8	9	18														
4	19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	28	29	30	31	32	33	34	35	36						
5	37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	46	47	48	49	50	51	52	53	54						
6	55	Cs	56	Ba	57	*	72	Hf	73	Ta	74	W	75	Re	76	Os	77	78	79	80	81	82	83	84	85	86						
7	87	Fr	88	Ra	89	+	104	Rf	105	Ha	106	Sg	107	Bh	108	Hs	109	110	111	112	113	114	115	116	117	118						
		s-block		d-block										p-block																		
f-block	Lanthanide Series		57	*La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu
	Actinide Series		89	+Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr

Periodic Table of Elements

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Transition Metals



Rare Earth Metals



# Periodic Table

Group 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18																			
IA																		VIIIA	
1	<b>H</b>																2		
2	<b>Li</b>	<b>Be</b>																<b>He</b>	
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4	<b>K</b>	<b>Ca</b>	<b>Sc</b>	<b>Ti</b>	<b>V</b>	<b>Cr</b>	<b>Mn</b>	<b>Fe</b>	<b>Co</b>	<b>Ni</b>	<b>Cu</b>	<b>Zn</b>	<b>Ga</b>	<b>Ge</b>	<b>As</b>	<b>Se</b>	<b>Br</b>	<b>Kr</b>	
5	<b>Rb</b>	<b>Sr</b>	<b>Y</b>	<b>Zr</b>	<b>Nb</b>	<b>Mo</b>	<b>Tc</b>	<b>Ru</b>	<b>Rh</b>	<b>Pd</b>	<b>Ag</b>	<b>Cd</b>	<b>In</b>	<b>Sn</b>	<b>Sb</b>	<b>Te</b>	<b>I</b>	<b>Xe</b>	
6	<b>Cs</b>	<b>Ba</b>	*	<b>Hf</b>	<b>Ta</b>	<b>W</b>	<b>Re</b>	<b>Os</b>	<b>Ir</b>	<b>Pt</b>	<b>Au</b>	<b>Hg</b>	<b>Tl</b>	<b>Pb</b>	<b>Bi</b>	<b>Po</b>	<b>At</b>	<b>Rn</b>	
7	<b>Fr</b>	<b>Ra</b>	+	<b>Rf</b>	<b>Ha</b>	<b>Sg</b>	<b>Bh</b>	<b>Hs</b>	<b>Mt</b>	<b>Ds</b>	<b>Rg</b>	<b>Uub</b>	<b>Uut</b>	<b>Uuq</b>	<b>Uup</b>	<b>Uuh</b>	<b>Uus</b>	<b>Uuo</b>	
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Halogens



Noble Gasses

Chalogens

