

## Chemistry 6A Fall 2007

Dr. J. A. Mack

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Friday 9/14/07

*Office Hrs on website*

*Chem. 6A next week:*

Lab: Experiment **2** (*You will need goggles!!*)

Lecture: Chapter 2

*Lab books have been out in the book store, if you don't see them in the stacks, there are some in the back... go ask.*

No goggles, no lab!  
No open toed shoes allowed!  
No pre-lab, no lab!  
No excuses!



*Cuz when it comes to OWL,  
I know:*

- When you log on!
- Where you logged in from!  
(IP address)
- How Long you were logged on!
- nd how many attempts you  
make per question!

*Quit slackin' and hop to it!*

*It's time to play...*

# Name that Element!

S sulfur

F Fluorine

lead Pb

silver Ag

*It's time to play...*

# Name that compound!

$\text{CuCl}_2$  copper (II) chloride

$\text{K}_2\text{SO}_4$  potassium sulfate

sodium acetate  $\text{NaC}_2\text{H}_3\text{O}_2$

Aluminum hydroxide  $\text{Al}(\text{OH})_3$

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*You need to learn nomenclature ASAP  
in order to keep up with the material!*

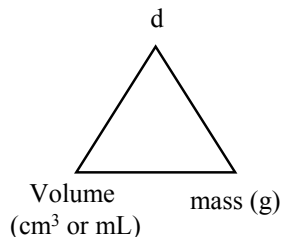
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## Density and its units:

Moving clockwise  
from  $d$ :



$$d = \frac{\text{mass}}{\text{Vol}}$$

Notice how the units relate:

If you know any two,  
you know the 3<sup>rd</sup>!

Given *density* and *Volume*,  
you can determine *mass*

and so on...

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PROBLEM: Mercury (Hg) has a density of  $13.6 \text{ g/cm}^3$ .  
What is the mass of 95 mL of Hg?

What are the units needed? mass (grams, g)

What units are given? density ( $\text{g/cm}^3$ )

What additional units are given? mL

What additional information do we know?  $1 \text{ mL} = 1 \text{ cm}^3$

So, to solve the problem, we must convert to the units **needed** from  
the units **given**.

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**PROBLEM:** Mercury (Hg) has a density of 13.6 g/cm<sup>3</sup>.  
What is the mass of 95 mL of Hg?

First begin with the quantity given:

95 mL

These units do not match the units of density so one must change them using a **conversion factor**:

A conversion factor is a relationship between two quantities; each equality yields two conversion factors.

$$1 \text{ mL} = 1 \text{ cm}^3 \quad \longrightarrow \quad \frac{1 \text{ mL}}{1 \text{ cm}^3} \text{ or } \frac{1 \text{ cm}^3}{1 \text{ mL}}$$

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**PROBLEM:** Mercury (Hg) has a density of 13.6 g/cm<sup>3</sup>.  
What is the mass of 95 mL of Hg?

Now set up a series of multiplication steps that convert the units:

$$95 \text{ mL} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} \times \frac{13.6 \text{ g}}{1 \text{ cm}^3} = 1292.00 \text{ g}$$

2 sf      exact      3 sf      ans. 2 sf

Cancel units that appear in the numerator and denominator:

Now round your answer to the correct number of sig. figs.:

$$1292.00 \text{ g} \quad \longrightarrow \quad 1300 \text{ g (2 sf)}$$

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### Calculating the density of an regular shaped object:

A 37.61 g block of a metal alloy has dimensions of 42 mm × 12 mm × 11 mm. What is its density in g/cm<sup>3</sup>?

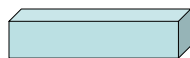
1<sup>st</sup>, put the calculator down!

mass is given

Recall that...

$$d = \frac{\text{mass}}{\text{Volume}}$$

You need volume!



$$V = L \times h \times w$$

$$d = \frac{37.61 \text{ g}}{(42 \text{ mm} \times 12 \text{ mm} \times 11 \text{ mm}) \times \left(\frac{1 \text{ cm}}{10 \text{ mm}}\right)^3}$$

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### Calculating the density of an regular shaped object:

A 37.61 g block of a metal alloy has dimensions of 42 mm × 12 mm × 11 mm. What is its density in g/cm<sup>3</sup>?

$$d = \frac{37.61 \text{ g}}{(42 \text{ mm} \times 12 \text{ mm} \times 11 \text{ mm}) \times \left(\frac{1 \text{ cm}}{10 \text{ mm}}\right)^3}$$

$$d = \frac{37.61 \text{ g}}{5544 \text{ mm}^3 \times \frac{1 \text{ cm}^3}{10^3 \text{ mm}^3}} = 6.8 \frac{\text{g}}{\text{cm}^3}$$

2 sf

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Let's say you want to determine the density of an irregular shaped object.  
You can measure the mass on a balance easily, but obtaining its volume is difficult.

17.01g



odd shape...

One way to determine the volume is to use a graduated cylinder.

The volume of the object is equal to the volume of water it will displace.



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First you fill the graduated cylinder with water...  
Then measure the volume...  
Then carefully add the object.



5.8 mL



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The level of the liquid rises due to displacement.  
The difference in volume is the volume of the object.

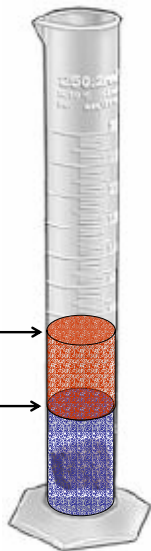
8.9 mL  
- 5.8 mL

3.1 mL

*The volume is accurate because the liquid fills in completely around the irregular shape!*

8.9 mL

5.8 mL



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Now the density can be determined:

17.01g



3.1 mL

odd shape...

$$d = \frac{\text{mass}}{\text{Vol}}$$

$$d = \frac{17.01\text{g}}{3.1\text{ mL}}$$

$$5.48710 \frac{\text{g}}{\text{mL}} \text{ or } 5.5 \frac{\text{g}}{\text{mL}}$$

(2 sf)

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## Chapter 2: Atoms and Molecules

### Chapter Learning Goals:

1. Write compound formulas using elemental symbols.
2. Identify the characteristics of protons, neutrons and electrons.
3. Determine the number of protons, neutrons and electrons of isotopes using atomic numbers and masses.
4. Calculate the formula weight of a chemical compound based on formula and atomic mass.
5. Use isotope percent abundances and masses to calculate the average atomic weights of elements.
6. Use the mole concept to relate the number of atoms, moles and grams of a material.

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## The Representation of Matter:

In chemistry we use chemical formulas and symbols to represent matter.

**Why?**

We are “**macroscopic**”: large in size on the order of 100’s of cm

Atoms and molecules are “**microscopic**”:  
on the order of  $10^{-12}$  cm

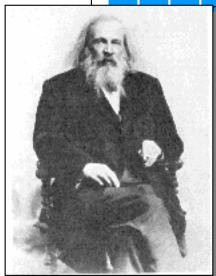
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## Where do we begin... The Periodic Table

**Legend:**  
■ Metals  
■ Metalloids  
■ Nonmetals



Dmitri Mendeleev (1834 - 1907)

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## The modern periodic table is defined by:

**Groups (families)  
(columns down)**

**Periods (rows across)**

**Metals**  
 ■ Alkali metals  
 ■ Alkaline-earth metals  
 ■ Transition metals  
 ■ Other metals

**Nonmetals**  
 ■ Hydrogen  
 ■ Semiconductors  
 ■ Halogens  
 ■ Noble gases  
 ■ Other nonmetals

<sup>1</sup> Copied from currently available IUPAC, 6th

<sup>2</sup> The systematic names and symbols for elements greater than 100 will be based on the official nomenclature by IUPAC.

A team at Lawrence Berkeley National Laboratory discovered the discovery of elements 110 and 111 in June 1996. The same team retraced the discovery in July 2001. The discovery of element 114 has been reported but not confirmed.

The atomic masses listed in this table reflect the precision of current measurements. Values in boldface parentheses are those of the isotope's most stable or most common isotopes. In calculations throughout the text, however, atomic masses have been rounded to two places to the right of the decimal.

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## Chemical Symbols and Formula:

### Elements:

H = hydrogen

O = oxygen

C = carbon

### Molecules:

H<sub>2</sub> = hydrogen

O<sub>2</sub> = oxygen

H<sub>2</sub>O = water

CO<sub>2</sub> = carbon dioxide

*Uh-Oh!*  
*this is confusing...*

*Yes it is...*  
*Get over it*  
*and get used to it!*

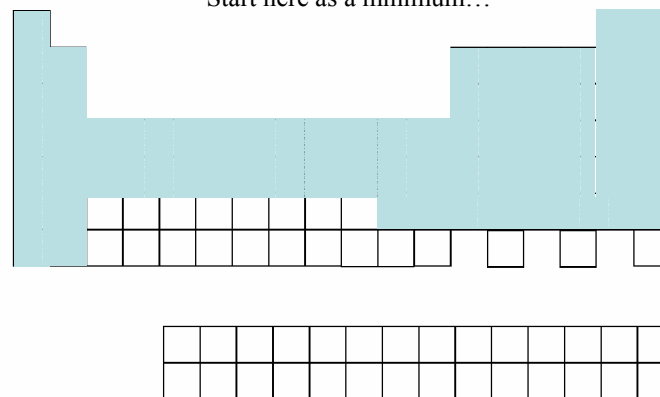
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## Which elements do we need to know?

Start here as a minimum...



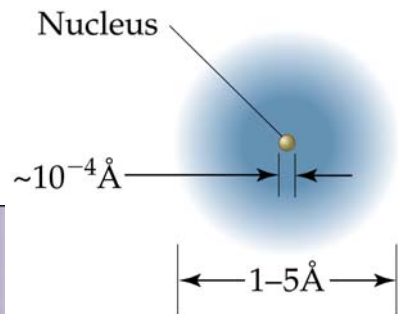
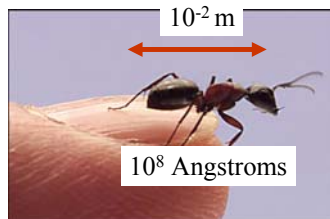
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Why do scientists use chemical symbols like **C**, **Al** and **Fe** to represent atoms?

***Because atoms are really small!***



1 Angstrom = 10<sup>-10</sup> m

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## How do I remember all of these things:

- 1: Memorize the common elements and their symbols
- 2: Make up flash cards and practice with your classmates, friends or family.
- 3: Work the exercises in the text!

Practice

Practice

Practice

Chemistry is really:

***Chem - is - try***

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## The Periods are labeled:

## The Groups are labeled:

The "A" refers to the "main group elements"

The "B" refers to the transition metal elements.

Key:  
 C — Atomic number  
 — Symbol  
 Carbon — Name  
 12.0107 — Average atomic mass

Metals:  
 Alkali metals  
 Alkaline-earth metals  
 Transition metals  
 Other metals

Nonmetals:  
 Hydrogen  
 Group 17 elements  
 Group 18 elements  
 Other nonmetals

50  
**Sn**  
 Tin  
 118.710

Tin is in group 4A (14) in the 5<sup>th</sup> period.

## Today's Periodic table

Group 1A elements are also known as the "Alkali Metals" as they form basic salts

### Today's Periodic table

Group 2A elements are also known as the **"Alkaline earth Metals"** as they are only found in the ground as metal salts (carbonates)

1A 1 H	2A 2 He											8A 18 He								
3 Li	4 Be											7A 17 F	9 F	10 Ne						
11 Na	12 Mg	3B 3 Sc	4B 4 Ti	5B 5 V											16 S	17 Cl	18 Ar			
19 K	20 Ca	21 Sc	22 Ti	23 V											34 Se	35 Br	36 Kr			
37 Rb	38 Sr	39 Y	40 Zr	41 Nb											52 Te	53 I	54 Xe			
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta											80 Pb	81 Bi	82 Po	83 At	84 Rn	
87 Fr	88 Ra	103 Lr	104 Rf	105 Db											114	116				
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm											68 Er	69 Tm	70 Yb
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu											100 Fm	101 Md	102 No

Metals  
Metalloids  
Nonmetals

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### Today's Periodic table

Group 2B – 8B elements are also known as the **"Transition Metals"**. They may be found in the earth as pure metals or as ores (salts).

1A 1 H	2A 2 He											8A 18 He								
3 Li	4 Be											7A 17 F	9 F	10 Ne						
11 Na	12 Mg	3B 3 Sc	4B 4 Ti	5B 5 V	6B 6 Cr	7B 7 Mn	8 Fe	9 Ni	10 Cu	11 Zn	12 Ga	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar			
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr			
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe			
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn			
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt												
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm											68 Er	69 Tm	70 Yb
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu											100 Fm	101 Md	102 No

Metals  
Metalloids  
Nonmetals

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### Today's Periodic table

Group 7A elements are also known as the **"Halogens"**. They form acids with hydrogen and exist as diatomic molecules. ( $F_2, Cl_2, \dots$ )

																	8A 18 He		
																	7A 17 F	9 F	10 Ne
																	17 Cl	18 Ar	18 Ar
																	35 Br	36 Kr	36 Kr
																	53 I	54 Xe	54 Xe
																	85 At	86 Rn	86 Rn

19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co											36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh											54 Xe	
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir											86 Rn	
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt												
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm											68 Er	69 Tm	70 Yb
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu											100 Fm	101 Md	102 No

Metals  
Metalloids  
Nonmetals

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### Today's Periodic table

Group 8A elements are also known as the **"Noble gasses"**. They are inert to reaction for the most part. He is found underground!

																	8A 18 He		
																	2 He	9 F	10 Ne
																	10 Ne	17 Cl	18 Ar
																	18 Ar	35 Br	36 Kr
																	36 Kr	53 I	54 Xe
																	54 Xe	85 At	86 Rn

19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co											36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh											54 Xe	
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir											86 Rn	
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt												
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm											68 Er	69 Tm	70 Yb
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu											100 Fm	101 Md	102 No

Metals  
Metalloids  
Nonmetals

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# Atomic Number, Z

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An element's identity is defined by the number of protons in the nucleus: **Z**

13	←	Atomic number
Al	←	Atom symbol
26.981	←	Atomic weight