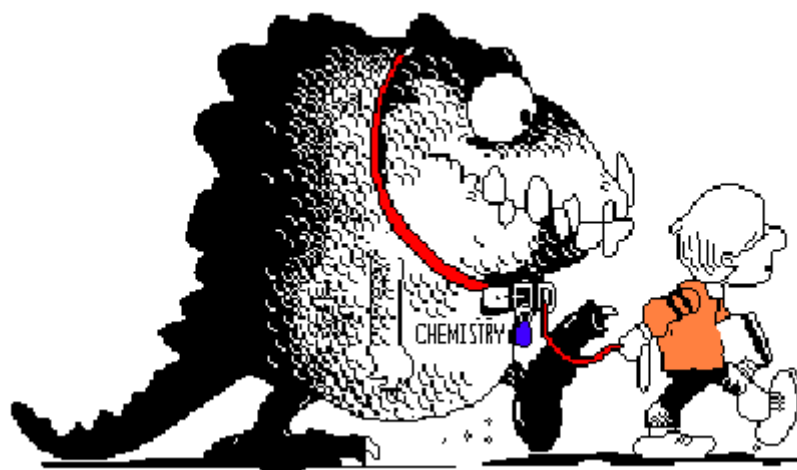


# CHEMISTRY 111

**Student Supplements  
and  
Problem Sets**

**Fall 2005**

**Instructor: Dr. Andrew M. Bryan**



## Supplementary Information

**This section contains information that complements the Textbook and Class Notes.**

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**CHEMISTRY 111 • First Handout of Things to Learn (rev 8/2004)**

The following will be used frequently during your stay in General Chemistry, it is to your advantage to begin learning (memorizing) them now!

- Common SI Units and Metric Prefixes (as listed in your textbook).
- Learn both Names and Symbols (Correct spelling is important) for Elements 1 - 36.
- Learn both Names and Symbols for the following important elements not included above (Barium, Silver, Tin, Lead, Gold, Platinum, Cadmium, Mercury, Polonium, Uranium, Iodine, Astatine, Xenon, Radon, Plutonium)
- Learn both Names and Symbols for the following common ions:

**Table 1 • Common Monatomic Cations and Anions**

Cation	Name	Anion	Name
$H^+$ ( $H_3O^+$ )	hydrogen or hydronium ion	$H^-$	hydride ion
$Li^+$	lithium ion	$F^-$	fluoride ion
$Na^+$	sodium ion	$Cl^-$	chloride ion
$K^+$	potassium ion	$Br^-$	bromide ion
$Cs^+$	cesium ion	$I^-$	iodide ion
$Be^{2+}$	beryllium ion	$O^{2-}$	oxide ion
$Mg^{2+}$	magnesium ion	$S^{2-}$	sulfide ion
$Ca^{2+}$	calcium ion	$N^{3-}$	nitride ion
$Ba^{2+}$	barium ion	$P^{3-}$	phosphide ion
$Al^{3+}$	aluminum ion		
$Ag^+$	silver ion		

**Table 2 • Common Polyatomic Ions**

Ion	Name	Ion	Name
$Hg_2^{2+}$	Mercury (I) ion	$NCS^-$	Thiocyanate ion
$NH_4^+$	Ammonium ion	$C_2H_3O_2^-$	Acetate ion
$NO_2^-$	Nitrite ion	$MnO_4^-$	Permanganate ion
$NO_3^-$	Nitrate ion	$Cr_2O_7^{2-}$	Dichromate ion
$SO_3^{2-}$	Sulfite ion	$CrO_4^{2-}$	Chromate ion
$SO_4^{2-}$	Sulfate ion	$CO_3^{2-}$	Carbonate ion
$HSO_4^-$	Hydrogen sulfate (or bisulfate) ion	$HCO_3^-$	Hydrogen carbonate (or bicarbonate) ion
$OH^-$	Hydroxide ion	$ClO_4^-$	Perchlorate ion
$CN^-$	Cyanide ion	$ClO_3^-$	Chlorate ion
$PO_4^{3-}$	Phosphate ion	$ClO_2^-$	Chlorite ion
$HPO_4^{2-}$	Hydrogen phosphate ion	$ClO^-$	Hypochlorite ion
$H_2PO_4^-$	Dihydrogen phosphate ion	$C_2O_4^{2-}$	Oxalate ion
$O_2^{2-}$	Peroxide ion	$S_2O_3^{2-}$	Thiosulfate ion

## CHEMISTRY 111 • Periodic Table of Elements

1A																8A	
1 H 1.008																2 He 4.003	
2A												3A	4A	5A	6A	7A	
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac† (227)	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une									

*	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
†	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

The periodic table provided for each of your tests will be similar to the one above. Become familiar with it as you memorize the names and symbols of the elements. Its organization and usefulness will be discussed in class.

**CHEM 111 Class Problems on Dimensional Analysis - Factor Label Method (rev.5/2004)****Simplified Rules for Counting Significant Figures**

1. Nonzero Digits are significant.
2. Zeros are significant, if not acting as PLACEHOLDERS for the decimal point.\*
3. Exact numbers have an infinite number of significant figures.  
\* If zeros can be removed by expressing the number in scientific notation, they are not significant!

**Simplified Rules for Determining Significant Figures for Mathematical Operations**  
3. Round the last digit kept up only if the digit following it is 5 or greater!

1. How many micrometers are there in 2.50 km?
2. What is the mass in kilograms for a man who weighs 198 pounds?
3. What is the height of Pike's Peak (14,110 feet) in kilometers?
4. Suppose a snail's pace ( $P_{sn}$ ) is measured to be 0.040 ft/min. What would it be in cm/s ?
5. A cube of steel measures 2.00 inches on each side. What is its volume in Liters?
6. It has been estimated that there is  $4 \times 10^{-6}$  mg of gold per Liter of seawater. If gold is selling at \$19.40 per gram, what would be the value of the gold in 1.00 cubic kilometer of the ocean?

## CHEM 111 Class Problems on Density and Percent Composition (rev.5/2004)

$$\text{Density} = \frac{\text{Mass of Stuff}}{\text{Volume of Stuff}}$$

$$\text{Percent by mass} = \frac{\text{mass of item of interest}}{\text{total mass of sample}} \times 100\%$$

Note:  $1 \text{ cm}^3 = 1 \text{ mL}$

**A Few Common Densities (at 20°C)**

<u>Substance</u>	<u>Density (g/mL)</u>
H <sub>2</sub> O (l)	1.00
NaCl (s)	2.16
Lead (s)	11.34
Gold (s)	19.32
Mercury (l)	13.6
Benzene (l)	0.880
Oxygen (g)	0.00133

1. What is the volume (in mL) of 250.0 mg of sodium chloride?
2. If your textbook were made of gold (it seems to be priced that way!), what would its weight be in pounds?
3. An EXCEDRIN tablet is composed of 250. mg of aspirin, 250. mg of acetaminophen, and 65 mg of caffeine. What is the %(w/w) of caffeine in a tablet?
4. A solution is 25.0 %(w/w) sugar. The solution has a density of 1.25 g/mL. How many grams of sugar are in 20.0 mL of solution?

**Other Conversion Examples**

Given:

$$1 \text{ frooble} = 2.38 \text{ telequads}$$

$$1 \text{ inch} = 16.78 \text{ telequads}$$

5. What is the density of gold in units of grams per cubic frooble?
6. Convert the speed of  $1.85 \times 10^8$  froobles/second to units of miles per hour.

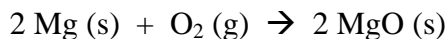
**CHEM 111 • Class Problems • General Stoichiometry (Rev.9/97)****Given 152.1 grams of lead (II) nitrate:**

1. What is the % (w/w) of Nitrogen in the sample?
  
  
  
  
  
  
  
  
  
  
2. How many moles of lead (II) nitrate does this sample represent?
  
  
  
  
  
  
  
  
  
  
3. How many grams of Pb (or  $\text{Pb}^{2+}$  ions) does this sample contain?
  
  
  
  
  
  
  
  
  
  
4. How many atoms of Oxygen are in this sample?

---

5. How many atoms of carbon are in 36.0 grams of xylene ( $\text{C}_8\text{H}_{10}$ ) ?

6. How many milligrams of calcium are in 1.250 grams of calcium carbonate?

**CHEM 111 - Chemical Reactions and Stoichiometry – Revised 9/2003****Example #1**

How many moles of  $\text{O}_2$  are required to make 8.8 moles of  $\text{MgO}$  ?

How many grams of  $\text{O}_2$  will react with 3.00 grams of  $\text{Mg}$ ?

**Example #2**

If 225. grams of vitamin C are completely burned, how many grams of  $\text{CO}_2$  can be produced?

**Example #3**

How many grams of  $\text{CO}_2$  can be formed by reacting 20.0 grams of  $\text{CH}_4$  (g) with 45.0 grams of  $\text{O}_2$  (g) ?

The previous reaction was carried out by Billy Bob and he measured an Actual Yield of 20.5 grams of  $\text{CO}_2$ . What is the percent yield of the reaction?

**Example #4**

How many grams of  $\text{Al}_2\text{O}_3$  (s) can be formed by reacting 2.40 moles of  $\text{Al}$ (s) with 3.60 moles of  $\text{O}_2$  (g)?

**Review Examples:**

1. What mass of iron (III) nitrate would contain 3.00 grams of oxygen atoms?  
2. An unknown ionic compound is found to have a molar mass of 134 g/mole. Decomposition analysis indicates the following % (w/w):

Na : 34.3%, C: 17.9%, O: 47.8%

What is the appropriate formula for this ionic compound

3. How many milligrams of  $\text{CO}_2$  (g) can be produced by completely burning 50.0 milligrams of  $\text{C}_2\text{H}_2$  (g) ?  
**CHEM111 • Solution Reaction Thoughts (Rev. F2000)**

**Terms to know concerning acids, bases, and salts:**

solubility, electrolyte, dissociate, ionize, strong electrolyte, weak electrolyte, non electrolyte

**Strong Acids** : (six most common)  $\text{HCl}$ ,  $\text{HBr}$ ,  $\text{HI}$ ,  $\text{HClO}_4$ ,  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$  (diprotic, first H is strong)

**Strong Bases**: examples: 1A and 2A metal hydroxides, such as  $\text{NaOH}$  and  $\text{Ca(OH)}_2$

**Weak Acids**: examples:  $\text{HC}_2\text{H}_3\text{O}_2$ ,  $\text{HNO}_2$ ,  $\text{HCN}$

**Weak Bases**: examples:  $\text{NH}_3$ ,  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$  ( many ionic compounds contain anions that act as bases)

**Solubility Rules for Common Salts in Water (adapted from Zumdahl)**

1. Most salts containing the alkali metal ions ( $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cs}^+$ ,  $\text{Rb}^+$ ) and the

ammonium ion ( $\text{NH}_4^+$ ) are soluble.

- Most salts of  $\text{NO}_3^-$ ,  $\text{ClO}_4^-$ ,  $\text{ClO}_3^-$ , and  $\text{C}_2\text{H}_3\text{O}_2^-$  are soluble.
- Most  $\text{Cl}^-$ ,  $\text{Br}^-$ , and  $\text{I}^-$  salts are soluble. **Notable exceptions** are salts containing the ions  $\text{Ag}^+$ ,  $\text{Pb}^{2+}$ , and  $\text{Hg}_2^{2+}$ .
- Most  $\text{SO}_4^{2-}$  salts are soluble. **Notable exceptions** are salts containing the ions  $\text{Ba}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Sr}^{2+}$ , and  $\text{Hg}_2^{2+}$ .
- All others** (e.g.,  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{PO}_4^{3-}$ ,) unless exempted above are only slightly soluble (i.e. insoluble).

Learn these rules and apply them in order to help you predict solubility.

### Assigning Oxidation Numbers

- The oxidation # of a pure element is zero.
- Simple ions have oxidation #'s equal to their charge.
- The sum of the oxidation #'s in a neutral compound is zero.  
The sum of the oxidation #'s in a polyatomic ion is equal to the charge on the ion.
- Assign some oxidation #'s based on the following order:  
F = -1, IA = +1, IIA = +2, IIIA = +3 (except Tl), H = +1, O = -2

### Steps to Balancing REDOX

- Write two Half Reactions.
- Mass Balance
  - Atoms other than H, O
  - Balance O with  $\text{H}_2\text{O}$
  - Balance H with  $\text{H}^+$
- Charge Balance (using e<sup>-</sup>)
- Make sure both half reactions have equal # of e<sup>-</sup> (multiply by an integer if necessary.)
- Add two half reactions, canceling identical species.
- \*6. If in basic solution, add  $\text{OH}^-$  to each side to remove  $\text{H}^+$  and cancel extra  $\text{H}_2\text{O}$ 's.

### Terms To Know concerning oxidation and reduction

oxidation number - a theoretical charge for an atom in a bond. The oxidation number is assigned by using a set of rules which assumes that the more electronegative atom gets all necessary electrons to complete its octet

oxidation - a loss of electrons (an increase in oxidation number)

reduction - a gain of electrons ( a decrease in oxidation number)

oxidizing agent - the species aiding in oxidation (receives the "lost" electrons)

reducing agent - the species aiding in reduction (donates the "gained" electrons)

## Chem 111- Quantum Number Handout (Rev10/96)

There are **four quantum numbers** which are used to describe possible locations for an electron in an atom:

- n** is the principal quantum number ( $n = 1, 2, 3, 4, \dots$ )
  - gives the relative distance of electron to the nucleus or what **shell** the electron is in.
- l** is the angular momentum (azimuthal) quantum number
  - identifies the **subshell** and the shape of its orbitals.
  - $l = 0, 1, 2, 3, \dots, (n-1)$  for a given shell (n) but typically is designated by the letters **s, p, d, f**,
- m<sub>l</sub>** is the magnetic quantum number
  - gives the orientation of regions (called **orbitals**) within each subshell (**l**).
  - maximum number of orbitals in a given subshell (**l**) =  $2l + 1$
  - **m<sub>l</sub>** has values ranging from ( $-l, \dots, 0, \dots, +l$ )
 

s subshell contains 1 orbital	<b>m<sub>l</sub></b> = 0
p subshell contains 3 orbitals	<b>m<sub>l</sub></b> = -1, 0, +1
d subshell contains 5 orbitals	<b>m<sub>l</sub></b> = -2, -1, 0, +1, +2
f subshell contains 7 orbitals	<b>m<sub>l</sub></b> = -3, -2, -1, 0, +1, +2, +3

Note: Orbitals within a subshell are generally called degenerate, meaning that they are equivalent in energy.

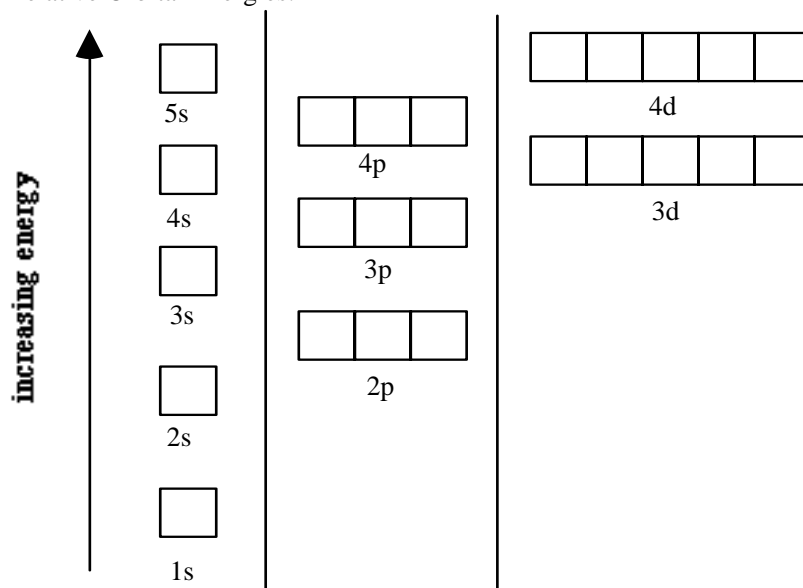
- m<sub>s</sub>** is the spin quantum number.
  - gives the relative spin of the electron "up" or "down".
  - **m<sub>s</sub>** has values ( $+\frac{1}{2}, -\frac{1}{2}$ )

Note: Two electrons in the same orbital must have opposite spins. (Pauli Exclusion Principle)

### Orbital Listing:

1s  
 2s 2p  
 3s 3p 3d  
 4s 4p 4d 4f  
 5s 5p 5d 5f 5g  
 6s 6p 6d 6f 6g 6h  
 7s 7p 7d 7f 7g 7h 7i

### Relative Orbital Energies:



**CHEM 111 • Class Problems on Quantum Numbers, Electron Configurations, Orbitals Diagrams**  
(10/99)

1. In the shell  $n = 5$ ,

How many subshells can exist?

How many orbitals can exist?

How many electrons will be present if the shell is completely filled?

2. For an atom of sulfur in its ground state:

What is the electron configuration of sulfur?

What is a possible set of quantum numbers for the last electron added to a sulfur atom?

How many p-electrons are in an atom of sulfur?

## CHEM 111 • Drawing Lewis Dot Structures (Rev.10/96)

## Rules Covalent Molecules and Ions

## A systematic approach

1. Sketch atoms in your molecule or polyatomic ion.
2. Pick the central atom .
  - usually the lowest in electronegativity
  - usually the lowest group number  
(i.e. can form the most bonds)
3. Count the total valence electrons .
  - add electrons for "-" ions
  - subtract electrons for "+" ions
4. Determine the number of electrons to meet "octet"  
8 for most elements, but only 2 for H
5. Line 4 - Line 3 = shared electrons ( $\div 2 = \#$  of bonds)
6. Place in bonds first as single bonds , then double or triple as necessary. Then fill in remaining electrons.

\*\*\*\*\*

Note: Best structures consider formal charge as well.

Formal Charge: a hypothetical charge for an atom based on the # of electrons it "thinks" it possesses.

FC = Formal Charge

NB = Nonbonding Electrons

B = Bonding Electrons

G# = Group # (e.g. 4A, 5A, . . .)

$$FC = G\# - NB - \frac{1}{2} B$$

- Rules: 1. Sum of FC for a molecule = 0, sum of FC for an ion = its charge  
2. Good structures keep FC on each atom as small as possible and try to place negative FC on more EN atoms.

**CHEM 111 Polarity of Molecules Poop Sheet • (Rev.10/96)**

1. Metals and Nonmetals usually have LARGE differences in electronegativity ( $\Delta EN \gg \gg 0$ ). They form highly polar bonds which are called IONIC! (Note: Polar simply means separation of charge. IONIC bonds have a complete separation of charge --- forming ions!)

2. Nonmetals usually have larger electronegativities than metals. However, when nonmetals are combined with other nonmetals, the resulting bonds usually have much smaller differences in electronegativity ( $\Delta EN > 0$ ) in comparison to ionic bonds. These result in only slightly polar, covalent bonds having only a partial separation of charge. The greater  $\Delta EN$  is the greater the polarity. (H forms extremely polar bonds with N, O, and F)

Note: a. If a molecule has nonpolar bonds, it to must be nonpolar.

b. If polar bonds occur within a molecule, the molecule will be polar UNLESS the bonds are symmetrically arranged.

c. Lone Pair electrons on the Central atom in a molecule indicate that the molecule is polar.

**Summary of Polarities of Nonmetal Species**

MONATOMIC:	<b>Nonpolar</b>	e.g. He, Ne, Ar, Kr, Xe, Rn
DIATOMIC:		
• same element ( X - X ) :	<b>Nonpolar</b>	e.g. H <sub>2</sub> , N <sub>2</sub> , Cl <sub>2</sub> , etc.
• different elements ( X - Y )	<b>Polar</b>	e.g. HF, HCl, NO, CO, etc.
POLYATOMIC		
• symmetric (AX <sub>2</sub> , AX <sub>4</sub> , AX <sub>6</sub> )	<b>Nonpolar</b>	e.g. CO <sub>2</sub> , CH <sub>4</sub> , CCl <sub>4</sub> , SF <sub>6</sub> , etc. (most hydrocarbons C <sub>m</sub> H <sub>n</sub> )
• assymetric (AX <sub>2</sub> E <sub>2</sub> , AX <sub>3</sub> E)	<b>Polar</b>	e.g. H <sub>2</sub> O, NH <sub>3</sub> , PCl <sub>3</sub> (also CH <sub>2</sub> Cl <sub>2</sub> )

Note : The AX<sub>m</sub>E<sub>n</sub> is represented for the VSEPR Theory described in your text.

A = Central Atom    X = Ligand (attached Atoms, identical)    E = Lone Pair Electrons

**More lone pair electrons on the central atom leads to a more bent shape in the molecule.**

<u>Type</u>	<u>Shape</u>	<u>Type</u>	<u>Shape</u>
AX <sub>2</sub>	Linear	AX <sub>3</sub> E	Trigonal Pyrimidal
AX <sub>3</sub>	Trigonal Planar	AX <sub>2</sub> E <sub>2</sub>	Angular, Bent
AX <sub>2</sub> E	Angular	AX <sub>6</sub>	Octahedral
AX <sub>4</sub>	Tetrahedral		

**CHEM 111 Gas Law Thoughts and Class Problems (Revised 8/99)****Units of Pressure**

$$1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr} = 14.7 \text{ psi} = 101.325 \times 10^3 \text{ Pa} = 101.325 \text{ kPa}$$

**STP: Standard Temperature and Pressure**

Standard Temperature = 0°C or its equivalent      Standard Pressure = 1atm or its equivalent

Under these conditions 1.00 mole of an ideal gas has a volume of 22.4 Liters

**Gas Constant (R):** =  $0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}$  (This is one example; it must have units of P,V,n, T)

**Useful equations:** (work best at lower pressures and moderate temperatures)

Fixed conditions:  $PV = nRT$        $PV = \frac{g}{MM} RT$       Changing conditions:  $\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$

Dalton's Law of Partial Pressures:  $p_T = p_a + p_b + p_c + \dots$       Mole Fraction:  $X_a = \frac{n_a}{n_T} = \frac{p_a}{p_T}$

**Questions:**

- 2.0 moles of He at room temperature occupies 250 mL at a pressure of 350 mmHg. What pressure is necessary to compress the gas to 100 mL?
- A balloon is filled with N<sub>2</sub> to a volume of 4.5 L in a room that is 25° C. What will the volume be outside where it is -10° C ?
- How many mL of O<sub>2</sub> are required to completely burn 30.0 mL of CH<sub>4</sub> ?
- How many moles of O<sub>2</sub>(g) is present, if it is trapped in a 550 mL container at 25.0° C and a pressure of 750 mmHg?
- A tank of He gas has a volume of 15.0 L and is pressurized to 10.0 atm at 30°C. What volume would a balloon be if it were to contain all this gas at 755 mmHg at 22° C?
- What is the density of O<sub>2</sub> gas at 25° C and 750 mmHg?
- A glass bulb contains 3.00 moles of He and 5.00 moles of H<sub>2</sub> . It is at a total pressure of 840 mmHg. What is the partial pressure of H<sub>2</sub> in the container?

## Problem Sets

**This section contains a listing of problems from the textbook and additional sample problems. It is recommended that you begin working on each section as it is introduced in class. Solutions to the textbook problems are listed in the student solutions manual that accompanies your textbook. Answers will be posted for the additional sample problems following coverage of the material. You are encouraged to work as many of the problems as possible.**

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**CHEM 111- #1 Conversions and Dimensional Analysis (revised 8/2003)**

Chapter 1 - Chemistry • Zumdahl (6th edition)

Text Questions (pp 31-38): 19,21,23,25,27,29,31,33,35,37,39,43,47,49,51,53,55,59,61,65,67,68,  
69,71,75,77,79,81

(See also Appendix One, pp A1 -A14 for a detailed discussion of Mathematical Procedures)

**Supplemental Problems •Conversions**

1. Convert the following to centimeters (cm)

- a. 12.5 in      b. 3.4 ft      c.
- $1.82 \times 10^3$
- km      d. 5.85 mm

2. Convert the following to milliliters (mL)

- a. 5.35 qt      b. 25.0 gal      c.
- $15.5 \text{ km}^3$
- d. 8.2
- $\mu\text{L}$

3. A company sells GARX for \$12.50 per quart. If GARX is a liquid with a density of 1.50 g/mL, how many grams of GARX can you purchase for \$2.75?

4. Given the following objects:

- a. A cylinder, Height = 12.0 cm, Diameter = 35.82 mm, Mass = 232 g
- 
- b. A block, Height = 2.0 in, Length = 20.0 in, Width = 5.8 in, Mass = 25.0 kg

Calculate the volumes(mL) and densities(g/mL) for each object:

5. Perform the following calculations (Try them without your calculator.):

- a.
- $1.20 \times 10^8 + 9.7 \times 10^7 =$
- \_\_\_\_\_
- 
- b.
- $1.66 \times 10^{-3} + 6.78 \times 10^{-2} =$
- \_\_\_\_\_
- 
- c.
- $6.02 \times 10^{23} + 6.02 \times 10^{21} =$
- \_\_\_\_\_
- 
- d.
- $(6.02 \times 10^{23})(6.02 \times 10^{21}) =$
- \_\_\_\_\_
- 
- e.
- $(7.7 \times 10^{99})(68 \times 10^{99}) =$
- \_\_\_\_\_
- 
- f.
- $(6.02 \times 10^{23})/(3.01 \times 10^{15}) =$
- \_\_\_\_\_
- 
- g.
- $(6.02 \times 10^{-13})/(4.23 \times 10^{-7}) =$
- \_\_\_\_\_
- 
- h.
- $(1.20 \times 10^8 + 9.7 \times 10^7)/(6.02 \times 10^{21}) =$
- \_\_\_\_\_

6. Which is a larger volume, 3.0 L or 3000  $\text{mm}^3$ ? (Hint: Convert  $\text{mm}^3$  to L)7. An ore is 25.0% copper, 35.0% iron, 22.0% aluminum, and the remainder is  $\text{SiO}_2$ . How many grams of iron are in 68.5 grams of ore? (Note: the percentages given are by mass.)

8. A solution is prepared by mixing 25.5 grams of salt with 115.0 mL of water. If the final volume of the solution is 120.0 mL, calculate the following (remember the density of water = 1.000 g/mL):

- a. What is the density of the salt solution?
- 
- b. What is the % w/w of salt in the solution?

9. A cylindrical tube is 30 cm high and 20 cm in diameter. The tube is initially filled with water. If water drips out the bottom at a constant rate of 50.0 mL/min, what will be the height of the water (cm) after 1.5 hours?

**CHEM 111- #2 Atomic Structure and The Periodic Table (revised 8/2003)**

Chapter 2 (Sections 2.1-2.7) - Chemistry • Zumdahl (6th edition)

Text Questions (pp 74-79): 15,17,19,21,23,25,27,29,31,35,37,39,41,43,45,47,49,51,55,73,87

## Supplementary Questions:

1. Describe the composition of an atom:

What are the three particles making up an atom?

What are the charges and relative masses of these particles?

Where are these particles found in the atom?

2. What is the difference between atomic number (Z) and mass number (A)?

3. What is the difference between an atom and an ion?

4. A new element was discovered on planet Lebpmac. This element has three isotopes Buiesium, Creekium, and Camelium. What must be the same in these isotopes? What must be different in these isotopes?

5. Complete the following table as directed (using the periodic table):

Name	Symbol	Type (metal, nonmetal, semi-metal)	# of protons	Group
aluminum				
	I			
			38	
	As			
tungsten				6B
	Mn			
		nonmetal		4A

**CHEM 111- #3 Naming Chemical Compounds(revised 8/2003)**

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•Chapter 2 (Sections 2.8)- Chemistry • Zumdahl (6th edition)

Text Questions (pp 74-79): 59,61,63,65,67,69,71,75,77,79

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Additional Questions:

1. **Name the following compounds:**

CuCl <sub>2</sub> _____	NO <sub>2</sub> _____
MgSe _____	Fe(NO <sub>3</sub> ) <sub>2</sub> _____
SO <sub>3</sub> _____	Cu <sub>3</sub> N <sub>2</sub> _____
PbCO <sub>3</sub> _____	Co(HSO <sub>4</sub> ) <sub>3</sub> _____
CaSO <sub>4</sub> _____	Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub> _____
N <sub>2</sub> O <sub>4</sub> _____	Li <sub>3</sub> PO <sub>4</sub> _____

2. **Write the chemical formulas for the following compounds**

sodium sulfide _____	cobalt (II) nitrate _____
sulfur dichloride _____	calcium acetate _____
iron (II) oxide _____	phosphorus triiodide _____
manganese (II) hydroxide _____	aluminum permanganate _____
titanium (IV) sulfate _____	magnesium hypochlorite _____

3. **Write the correct formula for the following acids:**

permanganic acid _____
sulfurous acid _____
hydrobromic acid _____
hypochlorous acid _____
bromic acid _____

**CHEM 111- #4 The Mole Concept and Avogadro's Number(revised 8/2003)**

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•Chapter 3 (Sections 3.1-3.5) - Chemistry • Zumdahl (6th edition)

Text Questions (pp 121-130):

Mole relationships: 19,21,23,27,29,31,33,35,37,39,41,43,45,47,49,51,103,109

% Comp., Empirical and Molecular Formulas : 53,55,57,59,61,63,67,69,71,105,107

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1. What is the mass of  $3.01 \times 10^{21}$  atoms of mercury?
2. How many milligrams of  $\text{Br}_2$  are in  $4.8 \times 10^{20}$  molecules of  $\text{Br}_2$ ?
3. What is the mass of one mole of  $\text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$  ?
4. How many atoms of nitrogen are in 25.8 mg of cobalt (III) nitrate?
5. If a sample of  $\text{FeSO}_4$  contains 25.0 grams of oxygen atoms, how many moles of iron does it contain?

**For questions 6 - 7** Given the following compounds:

a.  $\text{ClF}$       b.  $\text{HClO}_2$       c.  $\text{CuCl}_2$       e.  $\text{PuOCl}$

6. What is the molar mass of each compound?
  7. What is the % (w/w) Cl in each compound?
- 
8. Vitamin E is a compound containing 29 carbon atoms per molecule and is 80.87% carbon by weight. What is its molar mass? (Hint: What are the units of molar mass, and what does % by weight mean?)
  9. A compound has the following elemental composition(percent by mass):  
Hydrogen - 3.26%  
Carbon - 19.4%  
Oxygen - 77.4%  
Determine the empirical formula for this compound?

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**CHEM 111- #5 Balanced Chemical Equations and Stoichiometry(revised 8/2003)**


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**•Chapter 3 (Sections 3.6-3.9) - Chemistry • Zumdahl (6th edition)**

Text Questions (pp 121-130):

Balancing Equations: 75,77,79,81

Reaction Stoichiometry: 85,87,89,91,111

Limiting Reactant and Yield: 93,95,97,101,121

Additional Questions:

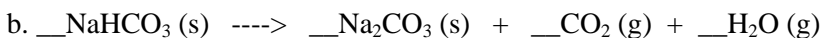
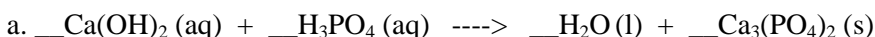
1. Write a balanced chemical equation for each the following reactions:

a. the complete combustion of glucose ( $C_6H_{12}O_6$ ) in oxygen

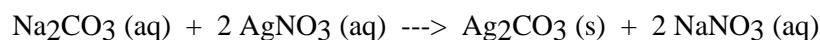
b. zinc metal react with hydrochloric acid solution to produce a solution of zinc chloride and bubbles of hydrogen gas

c. an aqueous solution of lead (II) nitrate and an aqueous solution of potassium phosphate react to produce a solution of potassium nitrate with lead (II) phosphate as a precipitate

2. Balance the following equations:

For the balanced reaction in (2 b):c. How many moles of  $Na_2CO_3$  can be formed from 3.25 moles of  $NaHCO_3$  ?d. How many grams  $CO_2$  can be produced from the decomposition of 52.8 grams of  $NaHCO_3$  ?e. If 50.0 grams of  $Na_2CO_3$  were formed from the decomposition of a sample of  $NaHCO_3$ , what was the mass of the original sample of  $NaHCO_3$ ?

3. Given the following balanced equation:

a. If 8.75 mmoles  $Na_2CO_3$  is mixed with excess  $AgNO_3$ , what is the maximum number of grams of  $Ag_2CO_3$  which can be formed?b. If 8.75 mmoles  $Na_2CO_3$  is mixed with 14.00 mmoles  $AgNO_3$ , what is the maximum number of grams of  $Ag_2CO_3$  which can be formed?

**PS#6 CHEM 111 • Solution Reactions • (revised 8/2003)**


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•Chapter 4 (Sections 4.1-4.10) - Chemistry • Zumdahl (6th edition)

Text Questions (pp 180-187):

Electrolytes/Molarity :11,13,15,17,19,21,23,25,27

Precipitation Reactions: 29,31,33,35,37,71

Acid Base Reactions: 45,47

Oxidation/Reduction: 57,59,61,63,65

Solution Chemistry Calculations/Titrations: 39,41,43,49,51,53,55,75,79,81,93\*

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Additional Problems:

**Write Total and Net Ionic Equations for the following precipitation reactions:**

1. A silver nitrate solution is mixed with an ammonium chromate solution.

2. A zinc nitrate solution is mixed with a sodium carbonate solution.

3. A iron (III) acetate solution is mixed with a sodium nitrate solution.

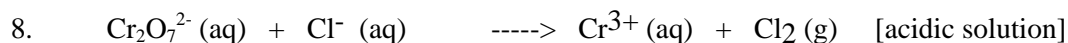
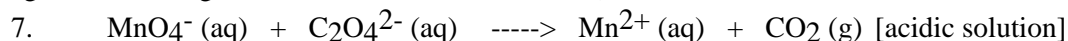
**Write Total and Net Ionic Equations for the following acid- base reactions:**

4. A perchloric acid solution is mixed with a lithium hydroxide solution.

5. An acetic acid solution is mixed with an potassium hydroxide solution.

6. A nitric acid solution is mixed with an ammonia solution.

**Balance the following equations** (Identify species oxidized and reduced, as well as oxidizing and reducing agents, also assign oxidation numbers to all atoms):



(continued on next page)

**PS#6 continues . . .****Solve the following:**

11. a. How many grams of NaOH must be required to make 250.0 mL of 0.112 M NaOH (aq).
- b. If 30.0 mL of this solution is diluted to 100.0 mL what will be the new concentration of NaOH?
12. A solution is prepared by dissolving 17.00 grams of  $\text{Mg}(\text{NO}_3)_2$  in enough water to make 250.0 mL of solution:
- a. Calculate the molarity of each ion present in solution.
- b. If 25.00 mL of this solution were diluted to 100.00 mL with water, what would be the "new" molarity of the ions?
13. In a titration, a student finds that 23.60 mL of 0.755 M  $\text{H}_2\text{SO}_4$  is required to completely neutralize 30.00 mL of a NaOH solution. What is the concentration of the NaOH solution?
14. Calculate the molar concentration of  $\text{Pb}^{2+}$  ions in 500.0 mL of an unknown  $\text{Pb}(\text{NO}_3)_2$  (aq) solution if 1.07 g of  $\text{PbSO}_4$  are formed upon adding excess  $\text{Na}_2\text{SO}_4$ .
15. How many grams of **precipitate** would form upon mixing 50.0 mL of 0.250 M barium nitrate with 60.0 mL of 0.150 M iron(III) sulfate?
16. Using the balanced equation from question #7, how many grams of  $\text{CO}_2$  (g) would be produced upon mixing 150.0 mL of 0.250 M  $\text{KMnO}_4$  (aq) with 125.0 mL of 0.350 M  $\text{Na}_2\text{C}_2\text{O}_4$  (aq) in acidic solution?

**PS #7 CHEM 111 • Electronic Structure , Periodic Trends (revised 8/2003)**

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•Chapter 7 (Sections 7.1-7.13) - Chemistry • Zumdahl (6th edition)

Text Questions (pp.336-344)

General :17,18,19,25,27,29,33

Light and Matter: 39,41,43,47,51,55,111

Quantum Mechanics and Electronic Structure: 61,63,65,67,69,71,73,77,79,119

Periodic Trends: 85,87,89,93

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**Additional Questions**

1. What does "excited state" mean when speaking of atomic structure?
2. What is the wavelength, frequency, and energy of "light" associated with an electron dropping from  $n=6$  to  $n=2$  in a hydrogen atom?
3. What is the first element containing a 4d electron. Write a "reasonable" set of quantum numbers describing this electron.
4. What is the ground state electron configuration for the following: K, Zr, P, Sb
5. What is the correct order for decreasing atomic radius of : Cl Ba Br Cs I
6. Which elements in the third period should be classified as paramagnetic in their ground state configuration?
7. Write a reaction showing the first ionization energy of Bromine:
8. Which of the halogens has the highest first ionization energy?  
Which of the alkali metals has the lowest first ionization energy?

**PS#8 CHEM 111 • Polarity, Bonding, and Molecular Shape (revised 8/2003)**

•Chapter 8 (Sections 8.1-8.13) - Chemistry • Zumdahl (6th edition)

Text Questions (pp.402-409)

General/Electronegativity: 13,14,15,17,19,21,23,25

Ions: 29,31,33,37

Lewis Structures/Formal Charge: 61,63,65,67,70,71,73,95

Molecular Structure and Polarity: 77,79,81,83,85,87,89

**Additional Questions**

1. What is the ground state electron configuration for the following:  $\text{Ti}^{2+}$   $\text{P}^{3-}$   $\text{K}^{+}$
2. Define isoelectronic. Give two ions which are isoelectronic with Krypton.
3. Draw Lewis Dot Structures for the following:

CO	CO <sub>2</sub>	N <sub>2</sub> O
HCN	PO <sub>4</sub> <sup>3-</sup>	SO <sub>3</sub> <sup>2-</sup>

4. Classify the type of bond the following pairs would most likely form:  
(ionic, pure covalent, polar covalent)

K,P \_\_\_\_\_

P,S \_\_\_\_\_

Cl,F \_\_\_\_\_

N,N \_\_\_\_\_

F,Al \_\_\_\_\_

Cu,S \_\_\_\_\_

O,I \_\_\_\_\_

H,S \_\_\_\_\_

5. What is the formal charge on S in SO<sub>3</sub><sup>2-</sup>? (Use structure from above.)

**PS# 9 - CHEM 111 • Gas Laws Problems (revised 8/2003)**

•Chapter 5 (Sections 5.1-5.8) - Chemistry • Zumdahl (6th edition)

Text Questions (pp.230-239)

Terms and Pressure: 17,19,23,25,27,29

General Gas Laws : 31,33,35,37,39,41,45,47

Other Gas Problems: 49,51,55,59,63,65,67,95,97,113\*

Diffusion and Effusion: 73,75,77,79,81

**Additional Questions**

- How many moles of O<sub>2</sub>(g) is present, if it is trapped in a 550 mL container at 25.0° C and a pressure of 750 mmHg?
- A tank of He gas has a volume of 15.0 L and is pressurized to 10.0 atm at 30° C. What volume would a balloon be if it were to contain all this gas at 755 mmHg at 22° C?
- What is the density of O<sub>2</sub> gas at 25° C and 750 mmHg?
- Fill in the missing quantity:

Sam ple No	Pressure <b>P</b>	Volume <b>V</b>	Number of moles <b>n</b>	Temp.. <b>T</b>	Mass <b>g</b>	Molar Mass	Density <b>g/L</b>	Volume this Sample would have at STP
1	1.00 atm			25.0° C	2.00 g	44.0		1.02 L
2		3.00 L	0.0500	400.0 K	7.30 g			
3		1.00 L		0.00°C	6.44 g	92.0	2.87	
4	608 torr	7.00 L	0.223			64.0		5.00 L
5	380 torr	15.0 L		298 K		4.00		

- A volume of 2.0 L of He at 46° C, and 1.2 atm pressure, was added to a vessel that contained 4.5 L of N<sub>2</sub> at STP.
  - Calculate the **total pressure** of the gas mixture at STP after the He was added.
  - Calculate the **partial pressure** of each gas in the mixture.
  - Calculate the **moles** of each gas in the mixture.
  - Calculate the **mole fraction** of each gas in the mixture.

## **Example Multiple Choice Test Questions**

**This section includes typical multiple choice questions from previous semester tests. The answers are given at the end of the section. These are not intended to be comprehensive, but to provide examples of how questions can be worded in a multiple choice format.**

**Set One – Twenty Random Multiple Choice questions from Old CHEM 111 Tests**

**Set Two – Test #1 from CHEM 111 – Fall 2003**

**Sample Multiple Choice Questions from a Previous Semester of CHEMISTRY 111, not intended to be comprehensive!**

- Which of the following best represents a chemical change?
  - a substance dissolves in water
  - a substance burns in air
  - a substance melts upon heating
  - all of these represent chemical changes.
  - none of these represent chemical changes.
- A certain pure substance is found to exist in units of three atoms of the same element. These units are called:
  - compounds
  - molecules
  - mixtures
  - composites
  - condominiums
- Which of the following numbers has the greatest number of significant figures?
  - 8.201
  - $3.00 \times 10^{-5}$
  - 0.00002750
  - 1000.50
  - all have the same number of significant figures
- $3.145 \text{ kg} = \underline{\hspace{2cm}} \text{ mg}$ 
  - $3.145 \times 10^{-3} \text{ mg}$
  - $3.145 \times 10^3 \text{ mg}$
  - $3.145 \times 10^{-6} \text{ mg}$
  - $3.145 \times 10^6 \text{ mg}$
  - 3.145 mg
- $1.36 \text{ mm}^2 = \underline{\hspace{2cm}} \mu\text{m}^2$ 
  - $1.36 \times 10^{-3} \mu\text{m}^2$
  - $1.36 \times 10^{-6} \mu\text{m}^2$
  - $1.36 \times 10^3 \mu\text{m}^2$
  - $1.36 \times 10^6 \mu\text{m}^2$
  - $1.36 \times 10^{12} \mu\text{m}^2$
- Which of the following pairs is CORRECT?
 

<u>Name</u>	<u>Symbol</u>
A. chloride ion	$\text{ClO}^-$
B. nitride ion	$\text{NO}_2^-$
C. carbonate ion	$\text{CO}_3^{2-}$
D. sulfite ion	$\text{S}^{2-}$
E. none of these is correct	
- An object has a length of 22.3 inches. What is the length of the object in prabs? (1.00 prab = 8.34 meters)
  - $6.79 \times 10^{-2}$  prabs
  - $1.05 \times 10^{-2}$  prabs
  - $7.32 \times 10^1$  prabs
  - 2.67 prabs
  - 4.72 prabs

8. A briefcase (dimensions: 4.50 in x 22.0 in x 11.0 in) is filled with gold. If gold has a density of 19.3 g/mL and is selling for \$308/ounce. What is the dollar value of the gold in the briefcase? (16 ounces = 1 pound)
- A.  $\$5.80 \times 10^5$   
 B.  $\$1.56 \times 10^3$   
 C.  $\$3.74 \times 10^6$   
 D.  $\$1.00 \times 10^4$   
 E.  $\$2.81 \times 10^6$
9. Which of the following is the appropriate symbol for the species containing 18 neutrons, 17 protons and 16 electrons?
- A.  ${}_{17}^{18}\text{Cl}^+$     B.  ${}_{18}^{35}\text{Ar}^+$     C.  ${}_{17}^{18}\text{Ar}^+$     D.  ${}_{17}^{35}\text{Cl}^+$     E.  ${}_{35}^{34}\text{Br}^+$
10. What is the oxidation state (or oxidation number) for sulfur in the formula,  $\text{H}_2\text{SO}_4$  ?
- A. +2                  B. +4                  C. +6                  D. +8                  E. -4
11. Which of the following gives the correct name and formula?
- | <u>Name</u>            | <u>Formula</u>           |
|------------------------|--------------------------|
| A. potassium nitrate   | $\text{KNO}_2$           |
| B. iron (III) chlorite | $\text{FeCl}_3$          |
| C. iron (II) sulfide   | $\text{FeS}$             |
| D. magnesium nitrite   | $\text{Mg}_2\text{N}_3$  |
| E. hydrochlorous acid  | $\text{HClO}(\text{aq})$ |
12. A compound has the formula  $\text{Ba}_3\text{X}_2$  ? What ion would best substitute for "X" in this compound?
- A. chlorite    B. sulfide    C. carbonate    D. thiosulfate    E. phosphate
13. How many moles of sodium are in 24.3 grams of sodium?
- A. 1.06 moles  
 B. 0.946 moles  
 C.  $6.38 \times 10^{23}$  moles  
 D.  $5.70 \times 10^{23}$  moles  
 E.  $6.02 \times 10^{23}$  moles
14. How many atoms are in a molecule of  $\text{CH}_3\text{CH}_2\text{OH}$  ?
- A. 3 atoms                          B. 9 atoms                          C.  $6.022 \times 10^{23}$  atoms  
 D.  $5.42 \times 10^{24}$  atoms            E.  $1.81 \times 10^{24}$  atoms
15. The correct number of atoms in 10.0 grams of  $\text{CaCO}_3$  (Molar Mass = 100.0) is:
- A.  $1.81 \times 10^{23}$  atoms                  B.  $3.01 \times 10^{23}$  atoms                  C.  $6.02 \times 10^{23}$  atoms  
 D.  $1.21 \times 10^{24}$  atoms                  E.  $1.21 \times 10^{23}$  atoms

16. A compound is found to have the following composition:

Na: 34.9%  
 B: 16.4%  
 O: 48.6%

The simplest formula for this compound is:

A.  $\text{NaBO}_2$     B.  $\text{NaBO}_3$     C.  $\text{Na}_2\text{B}_4\text{O}_7$     D.  $\text{Na}_3\text{BO}_3$     E.  $\text{Na}_3\text{BO}_4$

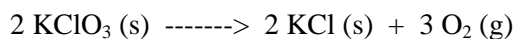
17. The Net Ionic Equation for mixing solutions of  $\text{NaOH}(\text{aq})$  and  $\text{AlCl}_3(\text{aq})$  is:

- A.  $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{NaCl}(\text{s})$   
 B.  $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$   
 C.  $\text{Al}^{3+}(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{Al}(\text{OH})_3(\text{s})$   
 D.  $\text{NaOH}(\text{aq}) \rightarrow \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$   
 E. There is no net reaction between these substances!

18. Which of the following solutions will cause a precipitate to be formed when added to a solution of  $\text{MgCl}_2(\text{aq})$ ?

- A. a solution of  $\text{AgNO}_3(\text{aq})$   
 B. a solution of  $\text{K}_2\text{CO}_3(\text{aq})$   
 C. a solution of  $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3(\text{aq})$   
 D. A and B  
 E. A, B, and C

19. In the following reaction:



14.0 grams of  $\text{KClO}_3$  yielded 1.40 grams of  $\text{KCl}$ . What is the percent yield?

- A. 6.08%    B. 16.4%    C. 11.0%    D. 32.9%    E. 10.0%

20. A possible set of quantum numbers for the last electron added to complete an atom of Selenium (Se) in its ground state is:

	n	l	m <sub>l</sub>	m <sub>s</sub>
A.	4	0	0	-1/2
B.	3	1	0	-1/2
C.	4	1	0	-1/2
D.	3	1	1	+1/2
E.	4	2	1	+1/2

Answers:

- |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. B  | 3. D  | 4. D  | 5. D  | 6. C  | 7. A  |
| 8. C  | 9. D  | 10. C | 11. C | 12. E | 13. A | 14. B |
| 15. B | 16. A | 17. C | 18. D | 19. B | 20. C |       |

**CHEM 111 – Test #1 – FALL 2003 with Key**

1. What scientist is most closely associated with the Plum Pudding Model of the atom?  
A. Democritus  
B. Dalton  
C. Thomson  
D. Rutherford  
E. Boyle
2. What scientist is most closely associated with determining the mass of an electron?  
A. Rutherford  
B. Dalton  
C. Thomson  
D. Chadwick  
E. Millikan
3. How many electrons are in  ${}^{59}_{27}\text{Co}^{3+}$ ?  
A. 24                  B. 27                  C. 29                  D. 30                  E. 32
4. How many neutrons are in an atom of the isotope, iron-57?  
A. 57                  B. 26                  C. 27                  D. 31                  E. 22
5. Which of the following is incorrectly paired?

	<u>Name</u>	<u>Symbol</u>
A.	hydride ion	$\text{H}^+$
B.	nitride ion	$\text{N}^{3-}$
C.	cyanide ion	$\text{CN}^-$
D.	sulfite ion	$\text{SO}_3^{2-}$
E.	all of these are correctly paired	
6. Which one of the following statements about atomic structure is false?  
A. The electrons occupy a very large volume compared to the nucleus.  
B. Almost all the mass of the atom is concentrated in the nucleus.  
C. The protons and neutrons in the nucleus are very tightly packed.  
D. The number of neutrons is always the same for atoms of a given element.  
E. All of the above statements are true.
7. Which of the following best indicates a chemical change?  
A. a substance changes shape  
B. a substance changes composition  
C. a substance changes temperature  
D. a substance changes color  
E. a substance changes states (of matter)
8. Which of the following represents a physical property?  
A. Lead has a density of 11.4 g/mL.  
B. Nitrogen has a boiling point of 77 K.  
C. Iron rusts when heated in moist air.  
D. Both A and B  
E. All of these

9. \_\_\_\_\_ is the smallest unit of matter that can represent a compound.  
A. an atom    B. a molecule    C. an ion    D. a proton    E. a mole
10. An ion is formed  
A. by an atom either gaining or losing protons.  
B. by an atom either gaining or losing electrons.  
C. by an atom either gaining or losing neutrons.  
D. two of the above are true  
E. A, B, and C are all true.
11. How many significant figures are represented by the measurement, 0.00320 grams.  
A. two    B. three    C. four    D. five    E. six
12. The smallest division (i.e. graduation mark) on a very sensitive thermometer is 0.01 °C. Which of the readings below would represent a temperature reported to the correct number of significant figures using this thermometer?  
A. 25 °C.    B. 18.1 C.    C. 24.15 °C.    D. 16.235 °C.    E. 10.2358 °C.
13. Which of the following is correctly paired?
- |    | <u>Name</u>                         | <u>Symbol</u> |
|----|-------------------------------------|---------------|
| A. | Tin                                 | Ti            |
| B. | Potassium                           | P             |
| C. | Manganese                           | Mg            |
| D. | Arsenic                             | Ar            |
| E. | All of these are incorrectly paired |               |
14. A sample of sugar (50.1 grams) and a sample of water (62.5 grams) are mixed to make a solution. How many significant figures should be used to report the total mass of the solution?  
A. one    B. two    C. three    D. four    E. five
15. 201 g = \_\_\_\_\_ mg  
A. 0.201  
B. 2.01  
C.  $2.01 \times 10^3$   
D.  $2.01 \times 10^5$   
E.  $2.01 \times 10^8$
16. Which of the following is the largest mass of sample  
A. 125. centigrams  
B. 12.5 grams  
C. 1250. micrograms  
D. 0.00125 kilograms  
E. 1250. milligrams
17. 13.1 cm = \_\_\_\_\_ ym (ym = “yoctometer” =  $10^{-24}$  m )  
A.  $1.31 \times 10^{-27}$     B.  $1.31 \times 10^{-25}$     C.  $1.31 \times 10^{23}$     D.  $1.31 \times 10^{25}$     E.  $1.31 \times 10^{27}$

18. Which of the following elements would be considered a transition metal?  
 A. Cs            B. Sr            C. Zr            D. As            E. Xe
19. A Sabbath Day's Journey in the Old Testament might be described as a distance of 2000 cubits. Using the conversion factors below, determine the distance in miles that is equivalent to a Sabbath Day's Journey: 1 cubit = 17.5 in      1 foot = 12 in      1 mile = 5280 ft  
 A. 0.26 mile    B. 0.38 mile    C. 0.55 mile    D. 0.72 mile    E. 1.8 miles
20. When Dr. Bryan was a young boy (long ago!) the engine displacement in a 1964 Ford Mustang was about 290 in<sup>3</sup> ("cubic inches"). Today's engine displacements are measured in Liters. What is the engine displacement of a 1964 Mustang in Liters?  
 A. about 1 Liter            B. about 3 Liters            C. about 4 Liters  
 D. about 5 Liters            E. about 6 Liters
21. At an alchemist's desk, melted gold drips into a pot at 1.50 mL/min. How many grams of gold will drip into the pot in 3.12 hours? (Density of Gold = 19.3 g/mL)  
 A.  $3.61 \times 10^3$  g            B.  $5.42 \times 10^3$  g            C.  $5.57 \times 10^2$  g  
 D.  $2.81 \times 10^2$  g            E.  $7.45 \times 10^1$  g
22. A vitamin tablet has a mass of 1.8799 grams. The label says that it contains 600. mg of calcium, 40. mg of magnesium, and 7.5 mg of zinc. The rest of the tablet's mass is composed of trace elements and an inert binder. What is the percent by weight (w/w) of magnesium in the tablet?  
 A. 6.2 % (w/w)            B. 0.40 % (w/w)            C. 1.2 % (w/w)  
 D. 2.1 % (w/w)            E. 34. % (w/w)
23. A cube of Zorkium is 1.21 inches per side and has a mass of 0.525 kg. What is Zorkium's density in g/mL?  
 A.  $1.81 \times 10^1$  g/mL    B.  $4.34 \times 10^2$  g/mL    C.  $2.96 \times 10^2$  g/mL  
 D.  $3.20 \times 10^1$  g/mL    E.  $1.02 \times 10^1$  g/mL
24. A very concentrated solution of nitric acid and water is determined to be 69.5 % (w/w) nitric acid. If this solution has a density of 1.35 g/mL, what volume (mL) of solution would contain 75.0 grams of nitric acid?  
 A. 79.9 mL    B. 55.6 mL    C. 70.4 mL    D. 51.5 mL    E. 52.1 mL
25. The substances, nitrogen, chlorine, and krypton are all \_\_\_\_\_.  
 A. halogens    B. noble gases    C. nonmetals    D. compounds    E. ions
26. Which of the following elements should have chemical properties most similar to calcium?  
 A. cadmium    B. scandium    C. potassium    D. manganese    E. magnesium
27. Metals are elements which \_\_\_\_\_.  
 A. tend to be malleable  
 B. tend to lose electrons to form cations  
 C. tend to be poor conductors of heat  
 D. Both A and B  
 E. A, B, and C

**Answers:**

**1-C    2-E    3-A    4-D    5-A    6-D    7-B    8-D    9-B    10-B    11-B    12-D    13-E**  
**14-D    15-D    16-B    17-C    18-C    19-C    20-D    21-B    22-D    23-A    24-A    25-C    26-E    27-D**