Part 1: Significant Figures, Unit Conversions, and Matter

1) Convert the following to scientific notation:
   a) 73                      f) 0.0000843
   b) 0.023                   g) 0.00568
   c) 6590                    h) 416500
   d) 178                     i) 2156000
   e) 458212                  j) 0.587

2) Convert the following from scientific notation:
   a) 6.3 x 10^{-7}          f) 7.558 x 10^{-3}
   b) 5 x 10^{6}             g) 2.001 x 10^9
   c) 5.6 x 10^{-4}          h) 2.66 x 10^{4}
   d) 4.55 x 10^{-7}         i) 8.5 x 10^{-1}
   e) 7.568 x 10^{2}         j) 2.556 x 10^{-2}

3) Carry out the following conversions giving your answers in scientific notation:
   a) 8.79 x 10^{-4} L to cm^3  f) 1.56 µg to g
   b) 5.68 m to cm              g) 2.5 L to mL
   c) 117 mg to g               h) 6.72 x 10^{-7} kg to mg
   d) 7.8 g to kg               i) 5.36 mL to L
   e) 101.3 cm^3 to m^3         j) 736.2 nm to m

4) Perform the following operations. Convert all answers to scientific notation, showing the correct number of significant figures
   A) 50.35 x 0.106 – 25.37 x 0.176
   B) 1252.7 – 9.4 x 10^2 x 12.3
   C) (0.562 x 19.34 – 7.00) x 4.321
   D) (0.4821 + 0.3285) 
      (0.0123 – 0.113)
   E) 25.00 x 0.1000 – 15.87 x 0.1036
   F) 3.65/0.3247 – 7.89/0.1254
   G) 0.0000481 – 0.000817
   H) 89.75 x 10^{-12} + 6.1157 x 10^{9}
   I) 0.000159 + 4.0074
   J) 45.2 x 23

5) How many sig figs are in the following numbers?
   a) 236 m                     f) 6532.000000 g
   b) 2000 people               g) 8500 L
   c) (1000 m)/(1 km)           h) 5.226 x 10^{-12} g
   d) 5026 g                    i) 400 m^2
   e) 600.0 mL                  j) 0.000023 cm

6) If the density of gold is 19.3 g/cm^3 and the density of water is 1.00 g/cm^3 what volume of water would be needed to be the same mass as a gold bar with the measurements: 5 cm x 4 cm x 15 cm?

7) Calculate the volume of a sheet of plywood with the following dimensions: Length: 2.78 cm; Width: 11.3 m; Thickness: 7.53 mm
8) How many seconds are there in a leap year?

9) A clock gains 0.050 seconds in one hour. How many minutes does the clock gain in 365 days?

10) The density of a substance is 23.7 mg/mL. What is the density in g/L?

11) A car with a maximum speed of 115 km/hr can travel how many meters per second?

12) Complete the following:
   A) _____mm² = 1 m²
   B) _____km² = 1 m²
   C) _____cm² = 1 mm²
   D) _____cm² = 1 mm²

13) Vioxx is a drug used to treat arthritis. If a patient takes one 125 µg tablet per day, how many milligrams of Vioxx are in their 1 month (30 day) supply?

14) A prescription pain reliever contains 30 mg of Codeine per tablet. The package directions recommend taking no more than 8 tablets in a 24 hour period. How many grams of Codeine per day is the maximum recommended dose?

15) What state of matter is represented by each of the following?
   a) ice 
   b) clouds in the sky 
   c) hydrogen in the sun
   d) rock 
   e) air 
   f) vegetable oil

16) Classify each of the following as either a chemical change (primarily) or a physical change.
   a) electrolysis of water 
   b) separating an alcohol-water mixture
   c) formation of fog 
   d) burning wood
   e) rusting iron 
   f) converting sand to glass

17) Draw a graph of temperature vs. energy showing the phase changes. Be sure to label all the phases, phase changes, melting points, boiling points etc.

18) For each of the following write whether it is a mechanical mixture (M), a solution (S), or a compound (C).
   a) soda pop 
   b) sugar 
   c) milk 
   d) muddy water
   e) baking soda (NaHCO₃) 
   f) pizza 
   g) bronze

19) Write the chemical formula for the following compounds:
   A. chlorine tetroxide 
   B. trisilicon tetranitride 
   C. iron(III) hydroxide
   D. radium carbonate 
   E. hydrobromic acid 
   F. disilicon hexaoxide
   G. sulfurous acid 
   H. chromium(II) oxalate 
   I. phosphoric acid
   J. dinitrogen pentoxide 
   K. tungsten(V) bromide 
   L. tin(II) bicarbonate
   M. mercury(I) nitrate 
   N. copper(I) phosphate 
   O. sulfuric acid
   P. beryllium oxide 
   Q. molybdenum(VI) iodide 
   R. ammonia

20) Write the name of the following compounds:
   A. CoF₃ 
   B. PBr₅ 
   C. KMnO₄ 
   D. FeC₂O₄
   E. HNO₃ 
   F. Sn(CN)₂ 
   G. LiOH 
   H. Na₂HPO₄
   I. Cu(NO₃)₂•6H₂O 
   J. NH₄NO₃ 
   K. N₂S₅ 
   L. CuSO₄
   M. V₂O₅ 
   N. Ni₃(PO₄)₂•8H₂O 
   O. H₂PO₄ 
   P. S₃N₂
   Q. CS₂ 
   R. W(CN)₆ 
   S. TaCl₃ 
   T. Li₂Cr₂O₇
Part 2: The Mole

1. What is the molar mass of the following compounds?
   a. Pb(C₂O₄)₂
   b. Ni(OH)₂
   c. Tin (IV) acetate pentahydrate
   d. CH₃COOH

2. Calculate the mass of the following:
   a. 7.01 mol of SiF₄
   b. 6.59 × 10⁻⁴ mol H₃PO₄
   c. 0.0765 mol Li₂HSO₄
   d. 6.85 mol CH₂CH₂ CH₂ CH₂CH₃

3. Calculate the number of moles of the following:
   a. 8.00 kg CrS
   b. 76.3 mg of I₂
   c. 2.00 L of N₂ at STP
   d. 35 g of Au

4. Calculate the number of atoms in the following:
   a. 1 molecule of CH₃COOH
   b. 70 molecules of BrF₅
   c. 2.78 mol NiSO₄•5H₂O
   d. 8.5 L of HCl gas at STP

5. What is the percentage composition of each element in:
   a. (NH₄)₂SO₄
   b. Cr₃(PO₄)₂•7H₂O

6. What is the empirical formula for the following compounds?
   a. 26.6% K, 35.4% Cr, 38.0% O
   b. 46.2% C, 7.69% H, 46.2% O
   c. 72.4% Fe, 27.6% O

7. What is the volume of 37.84 mol of CO₂(g) at STP?

8. Compute the mass needed to make 500.0 mL of solution at the indicated molarity.
   a. 0.85 M H₂SO₄
   b. 4.1 M Mg(OH)₂
   c. 0.069 M NaBr

9. What is the concentration of BaCl₂ if you mix 25.0 g of BaCl₂ into 450.0 mL water?

10. What would be the final concentration be if you added 30.0 mL of water to 15.0 mL of 1.750 M NaOH?

11. How many grams of Li₃PO₄ are contained in 7.45 L of 0.175 M Li₃PO₄(aq)?

12. What would be the final concentration of RbCl if you mixed 250.0 ml of 0.250 M RbCl with 350 mL water?
Part 3: Stoichiometry and Reactions

1) Translate the word equations into chemical symbols and balance the resulting equations. Include phases where stated. Include energy in the equations where appropriate.

a) lithium + water → lithium hydroxide + hydrogen (exothermic)
b) hydrogen chloride gas, when heated, decomposes to hydrogen gas and chlorine gas
c) water is separated by electrolysis into hydrogen gas and oxygen gas
d) solid iron (II) oxide and carbon powder react to form molten iron and carbon dioxide gas
e) Gaseous chlorine gas reacts violently with solid sodium to form solid sodium chloride

2) Balance the following equations and classify each reaction as one of: synthesis, decomposition, single replacement, double replacement, neutralization or combustion.

a) __Sr + __O2 → __SrO
b) __C6H12O6 + __O2 → __CO2 + __H2O
c) __H3PO4 + __KOH → __K3PO4 + __H2O
d) __H2O → __H2 + __O2
e) __Fe(HCO3)3 + __MgSe → __Fe2Se3 + __Mg(HCO3)2
f) __Br2 + __KCl → __KBr + __Cl2

3) Complete and balance the following reactions and classify each reaction

a) NO2 →
b) HCl + KOH →
c) Cu + Fe(NO3)2 →
d) MgSO4 + BeCl2 →

4) How many grams of sodium oxide are produced when 73.2g of sodium react completely with oxygen gas?

5) What mass of oxygen is required to react completely with 24.0g of propane?

6) If a sample of ethane is burned in excess oxygen, what mass of H2O is produced if the reaction also produces 63L of CO2 at STP?

7) How many grams of bromine are produced by the decomposition of 24.5g of hydrogen bromide gas?

8) Hydrazine (N2H4) is a rocket fuel prepared according to the reaction:

\[ 2 \text{NH}_3(aq) + \text{NaOCl}(aq) \rightarrow \text{N}_2\text{H}_4(aq) + \text{NaCl}(aq) + \text{H}_2\text{O}(l) \]

NaOCl is common “bleach” and NH3(aq) is produced by passing NH3(g) into water. If 1.25 x 10^-4 kg of hydrazine is required, how many L of ammonia gas (at STP) is required in the reaction?

9) a) What mass of CuO is required to make 18.0 g of Cu according to the reaction

\[ 2 \text{NH}_3 + 3 \text{CuO} \rightarrow \text{N}_2 + 3 \text{Cu} + 3 \text{H}_2\text{O} \]
b) If the reaction actually produces 6.5 g of Cu, what is the % yield?

10) Tetraethyl lead, Pb(C2H5)4, is an anti-knock agent which was added to some gasolines. Tetraethyl lead burns according to the equation

\[ 2 \text{Pb(C}_2\text{H}_5)_4(l) + 27 \text{O}_2(g) \rightarrow 2 \text{PbO}(s) + 16 \text{CO}_2(g) + 20 \text{H}_2\text{O}(l) \]
a) What volume of O2(g) at STP is consumed when 100.0g of PbO(s) are formed?
b) How many molecules of CO2 are formed when 1.00 x 10^4 g of tetraethyl lead is burned?
c) How many molecules of H2O are formed when 135 molecules of O2 react?
d) What volume of O2(g) at STP, in mL, is required to react with 1.00 x 10^15 molecules of tetraethyl lead?
Part 4: Periodic Table, Atomic Theory and Solution Chemistry

1. Which atom is bigger: Bi or P? Why?

2. Complete the following table:

<table>
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<tr>
<th>Atom/Ion</th>
<th>Atomic #</th>
<th>Mass #</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{39}\text{K}^+1$</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>$^{41}\text{Ca}$</td>
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<tr>
<td>$^{69}\text{Ga}^{+3}$</td>
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<td>$^{18}\text{O}$</td>
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<tr>
<td>$^{235}\text{U}^{+4}$</td>
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</tbody>
</table>

3. Naturally occurring silver consists of 51.8% Ag-107 and 48.2% Ag-109. What is the expected average molar mass of a sample of natural silver, expressed to 3 decimal places?

4. What are the electron configurations for:
   a) P    b) Cl   c) Ar   d) F$^{-1}$  e) S$^{-2}$ f) He

5. Name at least one trend among each of the following periodic families:
   a. Alkali Metals
   b. Alkaline Earth Metals
   c. Halogens
   d. Noble Gases

6. If a noble gas could form a +1 ion, which if the noble gases would form a +1 ion most easily?

7. With respect to electrons, how does an ionic bond differ from a covalent bond?

8. Indicate whether the following compounds are ionic, pure covalent, or polar covalent. Explain.
   a) NaCl    b) H$_2$O    c) NO$_2$    d) CS$_2$

9. Why does a certain covalent compound have a distinct odour while a certain ionic compound has no detectable aroma?

10. How many valence electrons are there in:
    a) Si    b) K$^{+1}$    c) Ne    d) O$^{2-}$    e) H$^{-1}$    f) N

11. Which would be miscible with water: ethanol or ether? Why?

12. Why are some solvents polar and some non-polar? Which would you use to dissolve salt?

13. Draw electron dot structures (Lewis Structures) for:
    a) C$_2$H$_4$    b) H$_2$    c) PO$_4^{3-}$    d) HCN    e) NH$_4^{+1}$

14. What will be the [Cl$^{-1}$] if 60.0 g of BaCl$_2$ is dissolved in 600.0mL of H$_2$O?

15. If 35.0g of V(NO$_3$)$_5$ is dissolved in 1.0L of H$_2$O, what will the [NO$_3^{-1}$] be?

16. What mass of NaBr must be dissolved in 4.9L to make a 5.2 M NaBr solution?

17. If 700.0mL of 1.9 M KCl is mixed with 1.05 L of 0.750M MgCl$_2$, what will the final [Cl$^{-1}$] be?
Part 5: Organic Chemistry

1. List the 10 straight chain alkanes by name.

2. Draw:
   a. 1,3,3-trifluoro-2-pentanol
   b. trans-2-hexene
   c. 3,4,5,6-tetraethyl-nonane
   d. 2-octyne
   e. 3,5-diethyl-4-methyl-heptane
   f. cyclooctene
   g. 2-bromo-3-heptyne
   h. 3-chloro-1-cyclobutanol
   i. 1-ethyl-3-propyl-benzene
   j. 1,3-cyclohexadiene
   k. 2,2,3,3-tetrabromo-pentane
   l. cis-3-nonene

3. Draw and name all 9 isomers of C₅H₁₀

4. Name:

   a)
   
   b)
   
   c) \begin{array}{c}
   \text{Br} \\
   \text{Br}
   \end{array}

   d)
   
   e)
   
   f)

   g)
   
   h)
   
   i)

   j)
   
   k)
   
   l) \begin{array}{c}
   \text{Cl} \\
   \text{Cl}
   \end{array}

   m)

   n)

   o) \begin{array}{c}
   \text{Cl} \\
   \text{Cl}
   \end{array}