

You are to complete the following problem set prior to the first day of class in September. I will collect your answers, which should be done on separate pages because there is not enough room in this question set unless you reprint them with much more space.

The difficulty of the problems varies, so don't be surprised if you are challenged by several of them. Do give them all a good try, though. I would estimate that this problem set should take 10 to 20 hours, so please do not leave it for the last day before the start of school.

You should use the text book, regents review book, yahoo answers (chemistry), mychemistrytutor.com, my website (kentchemistry.com) or any other resources you find helpful. Please also feel free to contact me at the email above if you have any questions.

1. Memorize the names, formulas and charges for the common anions. Aside from the following table, you can use Table E from the NYS reference table.

Formula	Ion Name	Formula	Ion Name	Formula	Ion Name
<b>-1 Charge</b>					
H <sup>-</sup>	Hydride	N <sub>3</sub> <sup>-</sup>	Azide	ClO <sup>-</sup>	Hypochlorite
F <sup>-</sup>	Fluoride	CN <sup>-</sup>	Cyanide	ClO <sub>2</sub> <sup>-</sup>	Chlorite
Cl <sup>-</sup>	Chloride	OH <sup>-</sup>	Hydroxide	ClO <sub>3</sub> <sup>-</sup>	Chlorate
Br <sup>-</sup>	Bromide	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>	Acetate	ClO <sub>4</sub> <sup>-</sup>	Perchlorate
I <sup>-</sup>	Iodide	H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	Dihydrogen Phosphate	SCN <sup>-</sup>	Thiocyanate
NO <sub>2</sub> <sup>-</sup>	Nitrite			HSO <sub>4</sub> <sup>-</sup>	Hydrogen Sulfate
NO <sub>3</sub> <sup>-</sup>	Nitrate	HCO <sub>3</sub> <sup>-</sup>	Hydrogen Carbonate		
MnO <sub>4</sub> <sup>-</sup>	Permanganate				
<b>-2 Charge</b>					
O <sup>2-</sup>	Oxide	CO <sub>3</sub> <sup>2-</sup>	Carbonate	SO <sub>4</sub> <sup>2-</sup>	Sulfate
O <sub>2</sub> <sup>2-</sup>	Peroxide	CrO <sub>4</sub> <sup>2-</sup>	Chromate	C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	Oxalate
S <sup>2-</sup>	Sulfide	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Dichromate	HPO <sub>4</sub> <sup>2-</sup>	Hydrogen Phosphate
S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	Thiosulfate	SO <sub>3</sub> <sup>2-</sup>	Sulfite		
<b>-3 Charge</b>					
N <sup>3-</sup>	Nitride	P <sup>3-</sup>	Phosphide	PO <sub>4</sub> <sup>3-</sup>	Phosphate

2. Memorize the names, formulas and charges for the common cations. Aside from the following table, you can use Table E from the NYS reference table.

Formula	Ion Name	Formula	Ion Name	Formula	Ion Name
<b>+1 Charge</b>					
H <sup>+</sup>	Hydrogen	K <sup>+</sup>	Potassium	NH <sub>4</sub> <sup>+</sup>	Ammonium
Li <sup>+</sup>	Lithium	Cs <sup>+</sup>	Cesium	H <sub>3</sub> O <sup>+</sup>	Hydronium
Na <sup>+</sup>	Sodium	Ag <sup>+</sup>	Silver	Cu <sup>+</sup>	Copper(I)
<b>+2 Charge</b>					
Mg <sup>2+</sup>	Magnesium	Zn <sup>2+</sup>	Zinc	Fe <sup>2+</sup>	Iron(II)
Ca <sup>2+</sup>	Calcium	Cd <sup>2+</sup>	Cadmium	Co <sup>2+</sup>	Cobalt(II)
Sr <sup>2+</sup>	Strontium	Sn <sup>2+</sup>	Tin(II)	Ni <sup>2+</sup>	Nickel(II)
Ba <sup>2+</sup>	Barium	Mn <sup>2+</sup>	Manganese(II)		

<b>Pb<sup>2+</sup></b>	Lead(II)	<b>Hg<sub>2</sub><sup>2+</sup></b>	Mercury(I)	<b>Hg<sup>2+</sup></b>	Mercury(II)
<b>+3 Charge</b>					
<b>Al<sup>3+</sup></b>	Aluminum	<b>Fe<sup>3+</sup></b>	Iron(III)		

3. Memorize the solubility rules for compounds that are soluble in water. You can also use reference table F in the NYS reference tables.

<b>Soluble Compounds contain:</b>	<b>Exceptions</b>
<b>Most common acids</b>	-
<b>Group 1 Metals</b>	None
<b>Ammonium</b>	None
<b>Nitrates</b>	None
<b>Acetate</b>	Silver Acetate is slightly soluble
<b>Chlorate</b>	None
<b>Perchlorate</b>	None
<b>Hydrogen Carbonate</b>	None
<b>Halides</b>	Ag <sup>+</sup> , Pb <sup>2+</sup> , Hg <sub>2</sub> <sup>2+</sup> , and CaF <sub>2</sub>
<b>Sulfates</b>	Ag <sup>+</sup> , Pb <sup>2+</sup> , Hg <sub>2</sub> <sup>2+</sup> , Ca <sup>2+</sup> , Ba <sup>2+</sup> , Sr <sup>2+</sup>

4. Memorize the solubility rules for compounds that are insoluble in water. You can also use reference table F in the NYS reference tables.

<b>Insoluble</b>	<b>Exceptions</b>
<b>Carbonates</b>	Group 1 metals, ammonium and dilute acids
<b>Oxides</b>	Group 1 metals, ammonium and dilute acids
<b>Phosphates</b>	Group 1 metals, ammonium and dilute acids
<b>Sulfides</b>	Group 1 metals, ammonium
<b>Hydroxides</b>	Group 1 metals, ammonium, dilute acids, Ca <sup>2+</sup> , Ba <sup>2+</sup> , and Sr <sup>2+</sup>
<b>Chromates</b>	Group 1 metals, ammonium, dilute acids, Ca <sup>2+</sup> , Mg <sup>2+</sup>

5. What is the difference between weight and mass? What are the SI units for each?
6. Perform the following conversions involving the liter: 1L = \_\_\_ dm<sup>3</sup> = \_\_\_ cm<sup>3</sup> = \_\_\_ m<sup>3</sup>
7. Calculate the mass ratio of the following properties for 1.0 kg of air versus 1.0 kg of iron at 25°C.
- A. Mass                      b. volume                      c. density
8. Write the number 1200 three ways: to 2, 3, and 4 significant figures
9. A container has a volume of 1.05 x 10<sup>3</sup> cm<sup>3</sup>. When filled with gas, the mass of the container + gas is 837.6 g. The mass of the container alone is 836.2 g. To the correct number of significant figures, what is the density of the gas?
10. Perform the following conversion: What is the cost of gasoline in US\$ per gallon for fuel in London that costs £0.75 per liter? (1£ = 2.03\$)
11. Describe how you would separate and recover into four separate containers the following four components of a mixture: liquid water (H<sub>2</sub>O(l)) + iron filings (Fe(s)) + sodium chloride dissolved in water (NaCl(aq)) + beach sand grains (SiO<sub>2</sub>(s)).

12. Classify each of the following as to pure substances or mixtures. If an item is a mixture, specify if it is heterogeneous or homogeneous. (a) concrete (b) seawater (c) magnesium (d) gasoline (e) air (f) tomato juice (g) iodine crystals (h) a nickel
13. How would you separate a mixture of granulated sugar and beach sand of comparable grain size?
14. Name the following elements H, Mg, Pb, Si, F, Sn, Cu, Ca, Ba, Cf, Mo, Se, Tl, V, Au, Zr
15. A solid white substance A is heated strongly in the absence of air. It decomposes to form a new white solid substance B and a gas C. The gas has exactly the same properties as the product obtained when carbon is burned with excess oxygen. What can you say about whether solids A and B and the gas C are elements or compounds?
16. In the process of attempting to characterize a substance, a chemist makes the following observation: The substance is a silvery white, lustrous metal. It burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into thin sheets or down into wires. It is a good conductor of electricity. Which of these characteristics are physical and which are chemical properties?
17. Use appropriate metric prefixes to write the following measurements without use of exponents. (a)  $6.5 \times 10^{-9}$  cm (b)  $3.35 \times 10^{-4}$  mL (c)  $2.5 \times 10^{-3}$  mol (d)  $4.23 \times 10^{-12}$  m<sup>3</sup> (e)  $12.5 \times 10^{-8}$  s (f)  $3.5 \times 10^3$  L (g)  $6.54 \times 10^9$  fs
18. Convert (a)  $2.52 \times 10^3$  kg to g (b) 0.0023 mm to nm (c)  $6.25 \times 10^{-4}$  s to ms
19. Calculate the mass of 1.00 ft<sup>3</sup> of gold metal.
20. Calculate the mass of 12.0 cm sphere of lead metal
21. A 200.0mg piece of gold can be hammered into a sheet that is 2.4 ft. by 10 ft. (a) What is the thickness of the sheet in m? (b) Quote the answer using the SI prefix so that there is no exponent needed.
22. Convert the following temperatures (a) 1000K to °C (b) 273°C to K
23. Indicate which of the following are exact numbers and which of the following are measurements. (a) mass of a paper clip (b) the surface area of a dime (c) the number of inches in a mile (d) the number of ounces in a pound (e) the number of microseconds in a week (f) the mass of 15 ounce can of coffee (g) the number of students in your first period class last year (h) the temperature of the sun (i) the mass of a postage stamp (j) the number of mL in a cubic meter of water (k) the average height of students in school.
24. What is the number of significant figures in the following measured quantities? 1282 kg (b) 0.00296 s (c) 8.070 mm (d) 8,070 mm (e) 0.0105 L (f)  $9.7750 \times 10^{-4}$  cm (g)  $1.689 \times 10^{-3}$  km (h) 0.0234 m<sup>2</sup> (i) 7,194,300 cm (j) 435.983 K (k) 204.080 g
25. Round each of the following numbers to three significant figures and express each in scientific notation (a) 143700 (b) 0.09750 (c) 890,000 (d)  $6.764 \times 10^4$  (e) 33,987.22 (f) -6.5559
26. Carry out the following operations, and express the answer with the appropriate number of significant figures. (a)  $1.24056 + 75.80$  (b)  $23.67 - 75$  (c)  $8900 \times 112.3$  (d)  $78,132/2.50$
27. A lake has an area of 15,500 mi<sup>2</sup> express the answers in m<sup>2</sup>?
28. If a person has 285 mg of cholesterol per 100.mL of blood, and a total blood volume of 5.3 L, how many grams of cholesterol does the person have in total in his blood?
29. An asthma drug dose is 6.0 mg/kg of body mass. What should the dose be for a 175lb person?

30. If an electric car goes 225 km on a single charge, how many charges are required for the 2850 mile trip from New York to Los Angeles? Assume the car is fully charged at the start of the trip in New York.
31. At 1.00 atm and 25.0°C, air has a density of 1.19 g/L. What is the mass, in kilograms, of air in a classroom that measures 26 ft by 41 ft by 8.0 ft?
32. A copper refinery produces a copper ingot weighing 150 lb. If the copper is drawn into wire whose diameter is 1.25 mm, how many meters of copper can be obtained from the ingot?
33. Surgeons removed 10. kg of fat from a patient by a procedure called liposuction. One fat cell has a mass of 0.80  $\mu\text{g}$ . How many fat cells were removed?
34. The gas constant R (as in  $PV=nRT$ ) is  $8.314 \text{ m}^3 \bullet \text{Pa}/\text{mol} \bullet \text{K}$ . Also  $R= 8.314 \text{ J}/\text{mol} \bullet \text{K}$ . Therefore  $1 \text{ m}^3 \bullet \text{Pa}$  equals 1 J. Using the fundamental SI units (m, kg, and s) demonstrate that  $1 \text{ m}^3 \bullet \text{Pa}$  indeed equals 1 J.
35. The formula for sarin (a toxic nerve agent that has recently been in the news) is  $\text{C}_4\text{H}_{10}\text{FO}_2\text{P}$  and draw its Lewis electron dot diagram.
36. Two students determine the percentage of lead in samples as a laboratory exercise. The true value is 22.52%. Student #1 had results that were 22.52%, 22.48% and 22.52%. Student #2 had results that were 22.64%, 22.58% and 22.62%. (a) Calculate the average for each student and tell which data set is more accurate (b) Calculate the absolute deviation for each value from the average value for each set. Which data set is more precise based on the average of the deviations?
37. The production of sodium hydroxide in the United States during 1994 was 25.83 billion pounds. (a) How many grams of NaOH were produced during 1994? (b) The density of NaOH is  $2.130 \text{ g}/\text{cm}^3$ . How many cubic meters of NaOH were produced?
38. Mercury is traded by the "flask", a unit that has a measure of 34.5 kg. What is the volume of a "flask" of mercury in liters at 25°C.
39. A 26.27 g sample of a solid is placed in a flask. Toluene, in which the solid is insoluble, is added to the flask so that the total volume of the solid together is 50.00 mL. The solid and toluene together have a mass of 52.65 g. The density of the toluene at the experimental temperature is 0.864 g/mL. What is the density of the solid?
40. Suppose you define your own temperature scale (G) using the freezing point ( $-115^\circ\text{C}$ ) and the boiling point ( $197.6^\circ\text{C}$ ) of ethylene glycol (the main ingredient in automotive antifreeze). You set the freezing point of ethylene glycol as  $0^\circ\text{G}$  and the boiling point as  $100^\circ\text{G}$ . On the G temperature scale, what is the temperature for the freezing point of water?
41. The world record for the marathon is 2 hours 4 minutes and 26 seconds (Haile Gebrselassie, Berlin Marathon, September 2003), The race length is 26 miles and 385 yards. What was Gebrselassie's average speed during the race in km/hr?
42. The annual global increase in carbon dioxide, the major greenhouse gas, are 5.5 gigatons from fossil-fuels, 6.5 gigatons from industrial activity and 1.6 gigatons from deforestation. What is the total annual increase in  $\text{CO}_2$  in kg. (NOTE 1 metric ton is 1000kg)
43. The U.S. quarter has a mass of 5.67 g and is 1.55 mm thick. (a) How many quarters would have to be stacked to reach 575 ft, the height of the Washington Monument? (b) What would be the mass of this stack? (c) What would be the dollar value of the stack? (d) As of January 2008, the

national debt was 9.3 trillion dollars. How many of these stacks would be needed to pay of the national debt?

44. A 15.0-cm long cylindrical glass tube, sealed at one end, is filled with ethanol. The mass of ethanol needed to fill the tube is 9.64 g. The density of ethanol is 0.789 g/mL. Calculate the inner diameter of the tube in centimeters.
45. Gold is an alloy (mixed) with other metals to increase its hardness from jewelry making. Consider a piece of gold jewelry that has a mass of 9.85 g and a volume of 0.675 cm<sup>3</sup>. The piece contains only gold and silver. Assuming the total volume of the jewelry piece is the sum of the volumes of the gold and silver it contains, calculate the percentage of gold (by mass) in the piece.
46. How many liters of water are in the Pacific Ocean if it has a water volume of 139 million cubic miles?
47. What are the six most abundant elements in the human body by mass?
48. A student finds that 15.20 g of nitrogen will react with 17.37 g, 34.74 g or 43.43 g of oxygen to form three different compounds. What are the empirical formulas of these three compounds? (hint-convert mass to moles)
49. Account for the fact that alpha ( $\alpha$ ) particles and beta ( $\beta$ ) particles are deflected in opposite directions by an electrical field.
50. How many chromium atoms, if lined up, would be needed to span 1.0 cm?
51. How many protons, neutrons and electrons are in each of the following (a)<sup>55</sup>Mn (b)<sup>40</sup>Ar (c) <sup>65</sup>Zn<sup>2+</sup> (d)<sup>79</sup>Se<sup>2-</sup> (e)<sup>184</sup>W (f)<sup>235</sup>U
52. The following nuclides are used in medicine. Indicate how many protons and neutrons there are in each. (a)phosphorous-32(b)chromium-51 (c) cobalt-60 (d) technetium-99 (e)iodine-131 (f) thallium-201
53. Fill in all the gaps in the table assuming all the atoms are neutral

Symbol	<sup>39</sup> K				
Protons		25			82
Neutrons		30	64		
Electron			48	56	
Mass #				137	207

54. Fill in the gaps of the table

Symbol	<sup>52</sup> Cr <sup>3+</sup>	<sup>131</sup> I <sup>-</sup>			
Protons			47		33
Neutrons			60	69	42
Electron			46	48	
Net Charge				2+	3-

55. Write the symbol for each of the following elements and indicate whether it is a metal, metalloid, or nonmetal. (a)silver (b)helium (c) phosphorous(d) aluminum (e) cadmium (f)calcium (g) bromine (h) arsenic
56. How many hydrogen atoms are there in the following? (a) C<sub>2</sub>H<sub>5</sub>OH (b) Ca(C<sub>2</sub>H<sub>3</sub>COO)<sub>2</sub> (c)(NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub>

57. Write the empirical formula to each of the follow molecular formulas. (a)  $S_4N_4$  (b)  $C_7H_{14}$  (c)  $C_6H_{10}O_2$  (d)  $P_4O_6$  (e)  $C_6H_{10}F_8$  (f)  $Si_3O_9$
58. Each of the following elements can form an ion in a chemical reaction. By referring to the periodic table or other references, predict the charge of the most stable ion of each. (a) Al (b) ca (c) S (d) I (e) Cs
59. Using available references, predict the formula and the name of the compound formed by the following pairs of elements. (a) Ga and F (b) Li and H (c) Al and I (d) K and S
60. The most common charge associated with silver in its compound is +1. Indicate the formulas you would expect for compounds formed between Ag and (a) iodine (b) sulfur (c) fluorine
61. Hydrogen can have oxidation states of +1, 0 and -1. Write the formula and names of for one chemical species for each of these oxidation states.
62. Predict the formulas for compounds formed from the following ions: (a)  $Ca^{2+}$  and  $Br^-$  (b)  $NH_4^+$  and  $Cl^-$  (c)  $Al^{3+}$  and  $C_2H_3O_2^-$  (d)  $K^+$  and  $SO_4^{2-}$  (e)  $Mg^{2+}$  and  $PO_4^{3-}$
63. Predict whether each of the following compounds is molecular or ionic (a)  $B_2H_6$  (b)  $CH_3OH$  (c)  $LiNO_3$  (d)  $Sc_2O_3$  (e)  $CsBr$  (f)  $NOCl$  (g)  $NF_3$  (h)  $Ag_2SO_4$
64. Give the chemical formula for (a) chloride ion (b) chlorite ion (c) chlorate (d) perchlorate ion (e) hypochlorite ion
65. Selenium, an element required nutritionally in very small amounts, forms compounds and ions analogous to those of sulfur (note: there proximity in the periodic table). Name the following ions. (a)  $SeO_4^{2-}$  (b)  $Se^{2-}$  (c)  $HSe^-$  (d)  $HSeO_3^-$
66. Name the following ionic compounds. (a)  $AlF_3$  (b)  $Fe(OH)_2$  (c)  $Cu(NO_2)_2$  (d)  $Ba(ClO_4)_2$  (e)  $Li_3PO_4$  (f)  $Hg_2S$  (g)  $Ca(C_2H_3O_2)_2$  (h)  $Cr_2(CO_3)_3$  (i)  $K_2CrO_4$  (j)  $(NH_4)_2SO_4$  (k)  $SrSO_4$  (l)  $ZnHPO_4$  (m)  $SnI_2$
67. Write the chemical formulas for the following compounds. (a) copper(I)oxide (b) potassium peroxide (c) aluminum hydroxide (d) zinc nitrate (e) mercury(I)bromide (f) iron(III) carbonate (g) sodium hypobromite (h) magnesium nitride (i) potassium hypochlorite (j) iron(II)sulfite
68. Provide the names or chemical formula, as appropriate, for each of the following acids. (a) sulfurous acid (b) HBr (c) hypochlorous acid (d) iodic acid (e)  $HBrO_3$  (f)  $H_2CO_3$  (g) nitrous acid (h) hydrocyanic acid
69. Provide the name or chemical formula appropriate, for each or the following molecular substances. (a)  $NF_3$  (b) dinitrogen tetroxide (c) hydrogen cyanide (d)  $SF_6$  (e)  $IF_5$  (f)  $XeO_3$  (g) tertaphosphorous hexasulfide
70. The oxides of nitrogen are often present in urban air pollution. Name each of the following oxides of nitrogen. (a)  $N_2O$  (b) NO (c)  $NO_2$  (d)  $N_2O_5$  (e)  $N_2O_4$
71. Write the formula for each of the following substances. (a) zinc carbonate can be heated to from zinc oxide and carbon dioxide (b) On treatment with hydrofluoric acid, silicon dioxide forms silicon tetrafluoride and water (c) Sulfur dioxide reacts with water to form sulfurous acid (d) The substance hydrogen phosphide, also known as phosphine, is a toxic gas. (e) Perchloric reacts with cadmium to from cadmium perchlorate (f) vanadium(III)bromide is a colored solid.
72. The nucleus of a potassium atom has a diameter on the order of  $1 \times 10^{-5} \text{ nm}$ . A potassium atom has a diameter of approximately 0.5nm. In terms of volume, how many times larger is the potassium atom than the potassium nucleus?

73. The element oxygen has three naturally occurring isotopes: oxygen-16, oxygen-17 and oxygen-18. Discuss the similarities and differences between these three types of atoms.
74. Consider the elements Ar, H, Ga, Al, Ca, Br, Ge, K and O. Pick the one that best fits each of the following descriptions. (a) an alkali metal (b) an alkaline earth metal (c) a noble gas (d) a halogen (e) a metalloid (f) a nonmetal listed in group 1 (g) a metal that forms a +3 ion (h) an element that resembles aluminum
75. The compound  $\text{Fe}_3\text{S}_4$  is magnetic. It is found in bacteria, which may use this magnetic property to help them be oriented in earth's magnetic field. If the sulfur charge is 2+, the Fe charge is not an integer. How can you explain this? (hint think of this mineral as a mixture of two different iron/sulfur compounds.)
76. Give the chemical names for each of the following common compounds. (a) NaCl (table salt) (b)  $\text{NaHCO}_3$  (baking soda) (c) NaOCl (Bleach) (d) NaOH (lye) (e)  $(\text{NH}_4)_2\text{CO}_3$  (smelling salts) (f)  $\text{CaSO}_4$  (plaster of Paris) (g)  $\text{Mg}(\text{OH})_2$  (Milk of Magnesia) (h) CaO (Lime) (i) HCl (muric acid)
77. Many ions and compounds have very similar names and there is a great potential for confusion. Write the correct chemical formulas to distinguish between each of the following pairs of chemicals. (a) calcium sulfide and calcium hydrogen sulfide (b) hydrobromic acid and bromic acid (c) aluminum nitride and aluminum nitrate (d) ammonia and ammonium ion (e) iron(II)oxide and Iron(III)oxide (f) potassium sulfate and potassium thiosulfate (g) magnesium chloride and manganese(II)chloride
78. The periodic table is ordered by increasing atomic number. As such, it is possible for elements to be out of order based on atomic mass. In fact, there are six pairs of elements that are out of order based on atomic mass. Find and list the six pairs.
79. Calculate the percent oxygen by mass and the percent hydrogen by mass of each of the following compounds or ions. (a)  $\text{H}_2\text{O}$  (b)  $\text{H}_2\text{O}_2$  (c)  $\text{OH}_2$  (d)  $\text{H}_3\text{O}^+$
80. For the reaction  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$ , give a complete list of the bonds that are broken and the bonds that are formed as the reactants are converted to products.