 Name: ____________________________

Chem 111 *10:10a section* *Final Exam Makeup*

This exam is composed of 50 questions. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations. Periodic table, solubility rules, and valuable constants are on the last page of the exam. Feel free to tear it off.

As discussed on the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

1. The average molecular speed in a sample of N_2 gas is 408 m/s at 303 K.

   The average molecular speed in a sample of CO_2 gas at the same temperature is:

   1) 304 m s^{-1} 2) 381 m s^{-1} 3) 478 m s^{-1} 4) 326 m s^{-1} 5) 600 m s^{-1}

   (4) Same temperature means same kinetic energy, so **(OWL 12-6d)**

$$KE = \frac{1}{2} m_{N_2} u_{N_2}^2 = \frac{1}{2} m_{CO_2} u_{CO_2}^2$$

$$u_{CO_2}^2 = \frac{m_{N_2}}{m_{CO_2}} u_{N_2}^2 = \frac{(2x14.01\ g\ mol^{-1})}{(12.01\ g\ mol^{-1}) + (2x16.00\ g\ mol^{-1})} (408\ m\ s^{-1})^2$$

$$= 105980 (m\ s^{-1})^2 = (326\ m\ s^{-1})^2$$

2. A 1.28 mol sample of Ar gas is confined in a 31.5 liter container at 26.5 °C. If 1.28 mol of F_2 gas is added while doubling both the volume and the temperature, the average kinetic energy per molecule will:

   1) decrease 2) remain the same 3) increase
   4) not enough information 5) I don't have a clue

   (3) Temperature determines average kinetic energy **Chapter 12**

3. A sample of Cl_2 gas is confined in a 2.0 liter container at 50 °C. Then 2.5 mol of He is added, holding both the volume and temperature constant. The pressure will increase because:

   1) As the number of molecule-wall collisions increases, the force per collision increases.
   2) With more molecules in the container, the molecules have higher average speeds.
   3) With more molecules per unit volume, the molecules hit the walls of the container more often.
   4) With higher average speeds, on average the molecules hit the walls of the container with more force.
   5) None of the Above

   (3) **Chapter 12**

4. A 1.96 mol sample of CO_2 gas is confined in a 49.1 liter container at 32.3 °C. If the temperature of the gas sample is increased to 55.0 °C, holding the volume constant, the **pressure will increase** because:
   1) With lower average speeds, the molecules hit the walls of the container less often.
   2) As the average speed increases, the number of molecule-wall collisions decreases.
   3) With higher average speeds, on average the molecules hit the walls of the container with more force.
   4) None of the above

   (3) **Chapter 12**

5. In our bodies, sugar is broken down with oxygen to produce water and carbon dioxide. How many moles of glucose ($C_6H_{12}O_6$) are required to react completely with 33.6 L of oxygen gas (O_2) according to the following reaction at 0 °C and 1 atm pressure? Note that the reaction may need balancing.

$$C_6H_{12}O_6\ (s) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$$

   1) 6.0 mol 2) 0.250 mol 3) 0.319 mol 4) 0.637 mol 5) 7.13 mol

   (2) First, balance the reaction:

$$C_6H_{12}O_6\ (s) + 6O_2\ (g) \rightarrow 6CO_2\ (g) + 6H_2O\ (l)$$

   6 mol of oxygen reacts with 1 mol of glucose, so first find the the number of moles of O_2 gas: $n = \frac{PV}{RT} = \frac{(1\ atm)(33.6\ L)}{(0.0820\ atm\ \ L\ \ mol^{-1}\ \ K^{-1})(273\ K)} = 1.50\ mol$

   Therefore, we need $\left(\frac{1}{6}\right)1.50\ mol = 0.250\ mol$ **OWL 12-3b**

6. What is the total volume of gaseous products formed when 160 L of bromine trifluoride (BrF_3) react completely to form Br_2 and F_2? (All gases are at the same temperature and pressure, before and after.)

   1) 85 L 2) 190 L 3) 380 L 4) 320 L 5) 160 L

   (4) First, write a balanced equation:

$$2BrF_3 \rightarrow Br_2 + 3F_2$$

   Look at mole ratios. 4 moles of gases are derived from 2 moles of reactants. Therefore, the volume should double. **OWL 12-3b**

7. The temperature of the atmosphere on Mars can be as high as 27 °C at the equator at noon, and the atmospheric pressure is about 8.0 mm of Hg. If a spacecraft could collect 2.80 m^3 of this atmosphere, compress it to a small volume, and send it back to earth, about how many moles would the sample contain?

1) 4.3 mol 2) 97 mol 3) 54 mol 4) 0.13 mol 5) 1.2 mol

$$n = \frac{PV}{RT} = \frac{(8.0mm)(2.8m^3)}{(0.0820\ atm\ L\ K^{-1}\ mol^{-1})(27+273)K}\left(\frac{atm}{760mm}\right)\left(\frac{100cm}{m}\right)^3\left(\frac{L}{1000cm^3}\right)$$

$n = 1.20\ mol$

(5) **Chapter 12**

8. HNO_3 is (a table on page 1 provides a clue):

1) a strong base 2) a weak base 3) a weak acid
4) a strong acid 5) none of the above

(4) **Chapter 5**

9. The concentration of H^+ in table wine (pH 3.4) is:

1) $3.98\text{x}10^{-4}$ M 2) $3.40\text{x}10^{-9}$ M 3) $3.98\text{x}10^{4}$ M
4) $3.40\text{x}10^{9}$ M 5) $1.00\text{x}10^{-7}$ M

(1) **Chapter 5** **Problem 72**

10. Reactions in water that produce gases tend to be:

1) unfavorable 2) ugly 3) favorable
4) endothermic 5) exothermic

(3) **Chapter 5**

11. Mixing $\mathbf{Na_2S}$ with $\mathbf{NH_4Cl}$ in water leads to precipitation of:

1) a S^{2-} salt 2) a Na^+ salt 3) a Cl^- salt
4) everything precipitates 5) no precipitation

(5) **inspired by OWL 5-2d**

12. You need to make an aqueous solution of 0.131 M ammonium sulfide for an experiment in lab, using a 250 mL volumetric flask. How much solid ammonium sulfide should you add?

1) 2.23 g 2) 3.15 g 3) 1.24 g 4) 2.74 g 5) 9.11 g

$(NH_4)_2S$ Molar Mass $= 2(14.01 + 4(1.008)) + 32.07 = 68.15\ g\ mol^{-1}$

$$x\left(\frac{\text{mol}}{68.15\text{g}}\right)\left(\frac{1}{250mL}\right)\left(\frac{1000mL}{L}\right) = 0.161\frac{mol}{L}$$

$x = 2.74g$

(4) **OWL 5-9c**

13. Which of the following describes the compound **$Ba(NO_3)_2$**?
   1) The compound is ionic.
   2) If the compound dissolved in water it would not conduct electricity.
   3) If the compound dissolved in water it would be a non-electrolyte.
   4) The compound is molecular.
   5) Both (1) and (2)

   (1) **(OWL question, Chapter 3)**

14. Which reaction below is a redox reaction?
   1) $NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO_3\ (aq) + H_2O\ (l)$
   2) $Na_2CO_3\ (aq) + 2\ HClO_4\ (aq) \rightarrow CO_2\ (g) + H_2O\ (l) + 2NaClO_4$
   3) $CdCl_2\ (aq) + Na_2S\ (aq) \rightarrow CdS\ (s) + 2\ NaCl\ (aq)$
   4) $Zn(OH)_2\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + 2\ H_2O\ (l)$
   5) None of the above

   (5) Look at redox changes – there are none. **Chapt 5 inspired by book**

15. The net ionic equation for the reaction of zinc sulfate and sodium hydroxide is:
   1) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (s) + Na_2SO_4\ (aq)$
   2) $ZnSO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Zn(OH)_2\ (aq) + Na_2SO_4\ (aq)$
   3) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (s)$
   4) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (aq)$
   5) No *net* reaction occurs

   (3) hydroxide salts are generally insoluble **(OWL 5-2c)**

16. In an endothermic process:
   1) work is performed on the surroundings
   2) heat is transferred to the surroundings
   3) work is performed on the system
   4) heat is transferred to the system

   (4) **Chapter 6**

17. Change in internal energy is best described as:
   1) ΔH 2) q+w 3) w 4) q 5) ΔG

   (2) ΔE is change in internal energy. ΔE=q+w **Chapter 6**

18. A negative value of ΔE means that:

1. heat is tranferred to the surroundings
2. heat is transfered to the system
3. energy in the form of heat and/or work is transferred to the surroundings
4. energy in the form of heat and/or work is transferred to the system

(3) **Chapter 6**

19. An automobile engine generates **2160** Joules of heat that must be carried away by the cooling system. The internal energy changes by **–2758** Joules in this process.

How much work to push the pistons is available in this process ?

1) 598 J 2) 4918 J 3) 2758 J 4) 2160 J 5) 4320 J

$$\Delta E = q + w \qquad w = \Delta E - q = (-2758\ J) - (-2160\ J) = -598\ J$$

(1) w is negative. The system does work on the surroundings. **Chapter 6**

20. Given the standard molar enthalpies of formation shown at right, determine ΔH for the reaction:

Subst	ΔH_f° (kJ/mol)
C_3H_8 (g)	-104.70
CO_2 (g)	-393.51
H_20 (g)	-241.83
H_20 (l)	-285.83

C_3H_8 (g) + 5 O_2 → 3 CO_2 (g) + 4 H_20 (g)

1) +530.6 kJ mol^{-1} 2) –530.6 kJ mol^{-1}

3) +2043 kJ mol^{-1} 4) –2043 kJ mol^{-1}

5) not enough information to determine

(4) $\left[3(-393.51) + 4(-241.83)\right] - \left[(-104.70) + 5(0)\right] = -2043\ kJ\ mol^{-1}$ **Chapt 6**

21. Given the information above, what is the heat required to vaporize water at 298 K?

1) –40.65 kJ mol^{-1} 2) 44.00 kJ mol^{-1} 3) 40.65 kJ mol^{-1}

4) –44.00 kJ mol^{-1} 5) not enough information to determine

(2) $(-241.83) - (-285.83) = 44.00\ kJ\ mol^{-1}$ **Chapt 6**

 Name: ______________________________

22. A 45.5 g sample of copper at 99.8 °C is dropped into a beaker containing 125 g of water at 18.5 °C. When thermal equilibrium is reached, what is the final temperature of the copper? The specific heat capacities of water and copper are 4.184 and 0.385 J g^{-1} K^{-1}, respectively.

1) 21.1 °C 2) 12.5 °C 3) 37.0 °C 4) 90.1 °C 5) 20.7 °C

$$q_{metal} + q_{water} = 0$$

$$\left(0.385\ J\ g^{-1}\ K^{-1}\right)(45.5 g)(x - 99.8)K + \left(4.184\ J\ g^{-1}\ K^{-1}\right)(125 g)(x - 18.5)K = 0$$

$$(x - 99.8)K = \frac{-\left(4.184\ J\ g^{-1}\ K^{-1}\right)}{\left(0.385\ J\ g^{-1}\ K^{-1}\right)}\frac{(125 g)}{(45.5 g)}(x - 18.5)K = -29.86(x - 18.5)K$$

$$x - 99.8 = -29.86x - (18.5)(-29.86)$$

$$x + 29.86x = 99.8 + 552.3 = 771.4$$

$$x = 21.1$$

(1) Chapt 6 Problem 20 at end of chapter. See also example 6.2

23. Given the following information:

N_2 (g) + $2O_2$ (g) → N_2O_4 (g) ΔH° = 9.2 kJ

$2N_2O$ (g) → $2N_2$ (g) + O_2 (g) ΔH° = -164.2 kJ

what is the standard enthalpy change for the reaction:

$2N_2O$(g) + $3O_2$ (g) → $2N_2O_4$ (g) ΔH° = ?

1) 155 kJ mol^{-1} 2) 146 kJ mol^{-1} 3) –155 kJ mol^{-1}

4) –146 kJ mol^{-1} 5) not enough information to determine

$2N_2$ (g) + $4O_2$ (g) → $2N_2O_4$ (g) ΔH° = 2(9.2) kJ

$2N_2O$ (g) → $2N_2$ (g) + O_2 (g) ΔH° = -164.2 kJ

(4) ΔH° = (18.4 – 164.2) kJ mol^{-1}= –145.8 kJ mol^{-1} OWL 6-6c

24. Which of the following has the strongest bond?

1) HF 2) HCl 3) HBr 4) HI

(1) – shortest bond, strongest bond OWL 9-xx

25. Being careful to consider molecular orbital theory (or at least valence bond theory), which of the following has the shortest bond length?

1) B_2 2) C_2 3) N_2 4) O_2 5) F_2

(3) N_2 – triple bond OWL 9-xx

Name: ______________________________

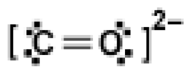
26. The central CO bond in the molecule CH_3–CO– CH_3 is best described as a:

1) triple bond
2) double bond
3) single bond
4) ionic bond
5) the molecule doesn't exist

(2) **From OWL units 9-1d and 9-2b. See Study Questions 13-14, Chapter 9**

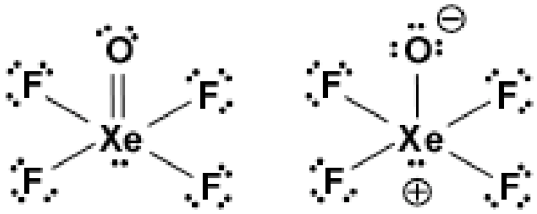
27. Draw the Lewis structure for **CO^{2-}**. What is the bond order of the CO bond?

1) triple
2) double
3) single

(2) double  **(12 valence electrons)** **OWL 9-xx**

28. Draw the Lewis structure for **$XeOF_4$** (Xe is the central atom). What is the hybridization on **Xe**?

1) sp^3d^2
2) sp^3d^3
3) sp^3d
4) sp^3
5) sp^2

(1)  **OWL 9-xx**

29. The molecule **$XeOF_4$** is:

1) nonpolar
2) polar
3) can't tell

(2) polar – the individual dipoles do not cancel out. **OWL 9-10b**

30. A molecule has sp^3d hybridization with one lone pair. The **electron pair geometry** of this molecule is:

1) tetrahedral
2) octahedral
3) linear
4) square pyramidal
5) trigonal bipyramidal

(5) **from OWL 10-2b**

31. Using molecular orbital theory, what is the bond order in the anion **F_2^-**?

1) 0.5
2) 1.0
3) 1.5
4) 2
5) 0

(1) **OWL 10-xx**

 Name: ________________________________

32. Consider the unbalanced equation:

$S_2O_3^{2-}$ (aq) + I_2 (aq) $\rightarrow$ $S_4O_6^{2-}$ (aq) + I^- (aq)

In the balanced equation, the coefficient in front of I^- (aq) is:

1) 1 2) 2 3) 3 4) 4 5) 6

(2) 2 $S_2O_3^{2-}$ (aq) + I_2 (aq) $\rightarrow$ $S_4O_6^{2-}$ (aq) + 2 I^- (aq) OWL 10-xx

33. Considering that same reaction

$S_2O_3^{2-}$ (aq) + I_2 (aq) $\rightarrow$ $S_4O_6^{2-}$ (aq) + I^- (aq)

A reducing agent in this reaction is:

1) $S_2O_3^{2-}$ 2) I_2 3) neither

(1) The S in $S_2O_3^{2-}$ is oxidized. It is a reducing agent OWL 10-xx

34. Which radiation below has the longest wavelength?

1) blue light (6.8×10^{14} Hz)
2) green light (6.0×10^{14} Hz)
3) red light (4.5×10^{14} Hz)
4) microwaves (2.4×10^{9} Hz)
5) x-rays (5.0×10^{18} Hz)

(4) It has the lowest frequency. Remember that $\lambda = c/\nu$

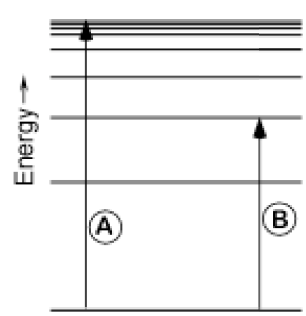
From OWL Unit 7-1b (and from last exam)

35. What is the wavelength of visible light with frequency 1.00×10^{15} Hz?

1) 600 nm 2) 300 nm 3) 500 nm 4) 162 nm 5) 280 nm

(2)
$$\lambda = \left(\frac{2.9998x10^{8}\,m}{s}\right)\left(\frac{1}{1.00x10^{15}\,Hz}\right)\left(\frac{Hz}{1}\,\frac{s}{1}\right) = 3.00x10^{-7}\,m$$
(OWL)
$$= 3.00x10^{-7}\,m\left(\frac{10^{9}\,nm}{m}\right) = 300nm$$

36. Consider the diagram at right. The transition labeled B is ***best*** described as :



1) emission 2) absorption
3) ionization 4) electron capture

(2) From OWL Unit 7-4c

37. The principle quantum number n specifies:

1) orbital orientation 2) subshell orbital shape
3) transition probability 4) orbital karma
5) energy and distance from nucleus

(5) **From OWL Unit 7-7b**

38. The correct spectroscopic notation for the sulfur ion S^- is:

1) $1s^2 2s^2 2p^6 3s^2 3p^2$ 2) $1s^2 2s^2 2p^6 3s^2 3p^3$
3) $1s^2 2s^2 2p^6 3s^2 3p^4$ 4) $1s^2 2s^2 2p^6 3s^2 3p^5$
5) $1s^2 2s^2 2p^6 3s^2 3p^6$

(4) **From OWL Unit 8-7c**

39. Which of the following elements has the greatest difference between the first and second ionization energies?

1) Mg 2) Si 3) P 4) Na 5) Cl

(4) **See Study Questions 67-68 & 72, Chapter 8 of K&T**

40. Which list below is in order of increasing electron affinity?

1) Ne < F < O < N 2) Si < P < S < Cl
3) F < Cl < Br < I 4) Be < Mg < Ca < Sr
5) none of the above

(2) **Chapter 8**

41. Which list below is in order of increasing ionization energy?

1) Cl < S < P < Si 2) Ne < F < O < N
3) F < Cl < Br < I 4) Sr < Ca < Mg < Be
5) none of the above

(4) **Chapter 8**

42. Which molecule below does not exist?

1) CaF_3 2) BeF_2 3) MgO 4) KCl 5) $BeCl_2$

(1) See Study Question 33, Chapter 9 of K&T – think about ionization required to make ionic compounds (Chapt 9.3)

43. The molecule HF can be thought of as having both ionic and covalent character. Given that statement, which of the following is likely to best describe the charge on each atom?

	H	**F**
1)	+1.0	–1.0
2)	+0.7	–0.7
3)	0.0	0.0
4)	-0.7	+0.7
5)	-1.0	+1.0

(2) This question is intended to get you thinking about concepts we will need in the next chapter. The key here is BOTH ionic and covalent. Answers (4) and (5) should be immediately eliminated – F wants to be negative, H positive. If the molecule were purely covalent (as in FF), (3) would be correct – but the molecule is not purely covalent. If the molecule were purely ionic (as in NaCl), (1) would be correct – but the molecule is not purely ionic. This leaves (2) as the only reasonable answer.

44. What is the most common charge of ions formed from **Fr**?

1) +1 2) +2 3) -1 4) -2 5) -3

(1) **+1** **(OWL question, Chapter 3)**

45. What is the formula of the compound formed between the ions $\mathbf{Co^{3+}}$ and $\mathbf{O^{2-}}$?

1) CoO 2) Co_2O 3) Co_2O_3 4) Co_3O_2 5) CoO_2

(3) Co_2O_3 -> 2 Co^{3+} + 3 O^{2-} **(OWL question, Chapter 3)**

46. What is the molar mass of **nitrogen trioxide**?

1) 62 g/mol 2) 32 g/mol 3) 44 g/mol 4) 16 g/mol 5) 46 g/mol

(1) **NO_3** $1\left(14.0067\frac{\text{g}}{\text{mol}}\right)+3\left(16.00\frac{\text{g}}{\text{mol}}\right)=62.0\frac{\text{g}}{\text{mol}}$ **(OWL, Chapt 3)**

47. A sample of citric acid, $\mathbf{C_6H_8O_7}$, contains 0.153 mol of the compound. What is the mass of this sample, in grams?

1) 3.02 g 2) 13.7 g 3) 20.2 g 4) 0.0730 g 5) 29.4 g

First we need the molar mass of citric acid:

$$6(\text{molar mass of C})+8(\text{molar mass of H})+7(\text{molar mass of O})=$$

$$6\left(12.011\frac{\text{g}}{\text{mol}}\right)+8\left(1.0079\frac{\text{g}}{\text{mol}}\right)+7\left(15.9994\frac{\text{g}}{\text{mol}}\right)=192.12\frac{\text{g}}{\text{mol}}$$

Use that to calculate the mass:

$$(0.153mol)\left(\frac{192.12g}{mol}\right)=29.4g$$

(5) **(OWL question, Chapt 3)**

 Name: ________________________________

48. What is the (mass) percent composition of **C** in citric acid, $\mathbf{C_6H_8O_7}$?

1) 6.87% 2) 4.20% 3) 37.5% 4) 28.5% 5) 6.00%

(3) Mass of C in 1 mol of the compound: $(6mol)(12.01g/mol) = 72.06g$

Mass of 1 mol of the compound: 192.12 g (see above)

Percent composition: $\frac{72.06g\ \mathrm{C}}{192g}100\% = 37.5\%$ **(OWL question, Chapt 3)**

49. Ethylene glycol, $C_2H_6O_2$, is an ingredient in automobile antifreeze. Its density is 1.11 g/cm^3 at 20°C. If you need exactly 1000 mL of ethylene glycol, what mass of the compound, in grams, is required?

1) 901 g 2) 90.1 g 3) 111g 4) 1000 g 5) 1110 g

$$1000mL\left(\frac{1cm^3}{1mL}\right)\left(\frac{1.11g}{cm^3}\right) = 1110g$$

(5) **(book question, Chapt 2)**

50. The correct designator for this course is:

1) SOM 555 2) Chem 363 3) Chem 256 4) Sports 1 5) Chem 111

(5)

Name: ________________________________

$$PV = nRT \qquad K.E. = \frac{1}{2}mu^2$$

$$E = h\nu = \frac{hc}{\lambda}$$

$1\ mL = 1\ cm^3$

$1\ atm = 760\ mm\ Hg$

$\Delta H_{vap}(H_2O) = 40.65\ kJ\ mol^{-1}$

$\Delta H_{fus}(H_2O) = 6.00\ kJ\ mol^{-1}$

$\Delta E = q + w = \Delta H - P\Delta V$

$h = 6.626x10^{-34}\ J\ s$

$c = 2.998x10^{8}\ m\ s^{-1}$

$N = 6.022x10^{23}\ mol^{-1}$

$R = 0.0820\ L\ \ atm\ K^{-1}\ \ mol^{-1}$

$R = 8.314\ J\ K^{-1}\ \ mol^{-1}$

Solubility Rules for some ionic compounds in water

Soluble Ionic Compounds

1. All sodium (Na^+), potassium (K^+), and ammonium (NH_4^+) salts are SOLUBLE.
2. All nitrate (NO_3^-), acetate ($CH_3CO_2^-$), chlorate (ClO_3^-), and perchlorate (ClO_4^-) salts are SOLUBLE.
3. All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) (Pb^{2+},Ag^+, Hg_2^{2+}) which are NOT soluble.
4. All sulfate (SO_4^{2-}) salts are SOLUBLE - - EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead (Ca^{2+}, Ag^+, Hg_2^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}) which are NOT soluble.

Not Soluble Ionic Compounds

5. Hydroxide (OH^-) and oxide (O^{2-}) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium (Na^+, K^+, Ba^{2+}) which are soluble.
6. Sulfide (S^{2-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium (Na^+, K^+, NH4$^+$, Ba^{2+}) which are soluble.
7. Carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium (Na^+, K^+, NH_4^+), which are soluble.

PERIODIC TABLE OF THE ELEMENTS

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.939	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** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	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** (99)	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** 181.0	74 **W** 183.8	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** 226.0	89 **Ac** 227.0	104 **Unq** (261)	105 **Unp** (262)	106 **Unh** (263)	107 **Uns** (262)	108 **Uno** (265)	109 **Une** (266)									