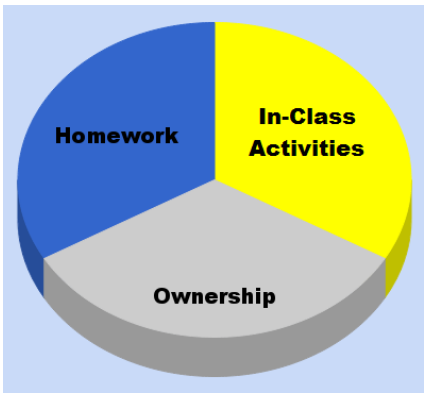
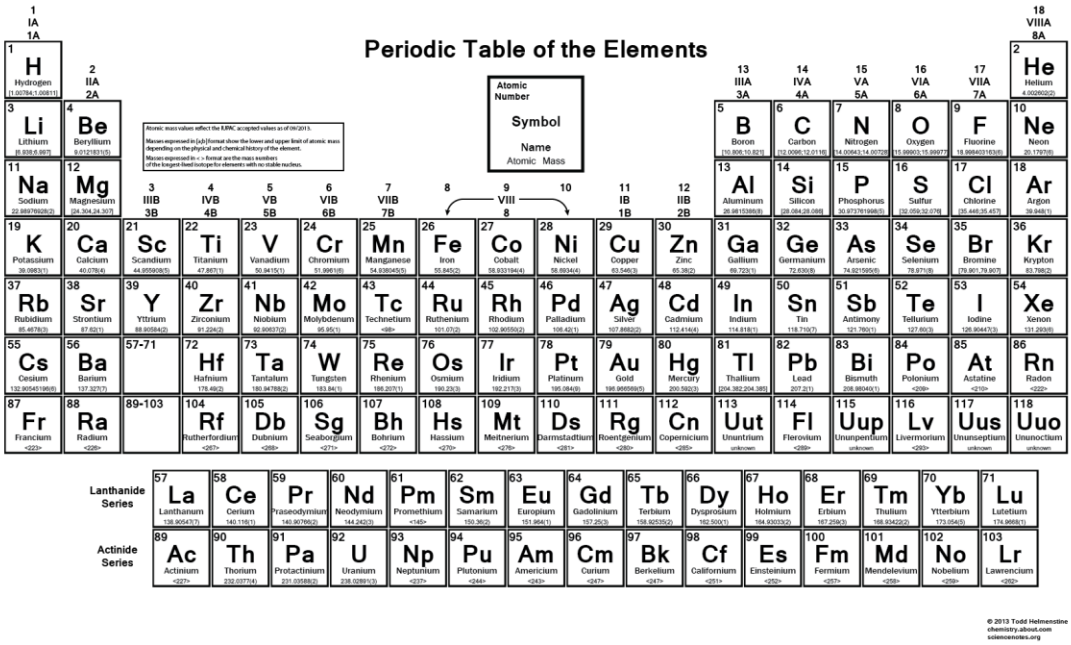
Worksheet 34 – CHEM 121 – Fall 2015



Your Name: _____

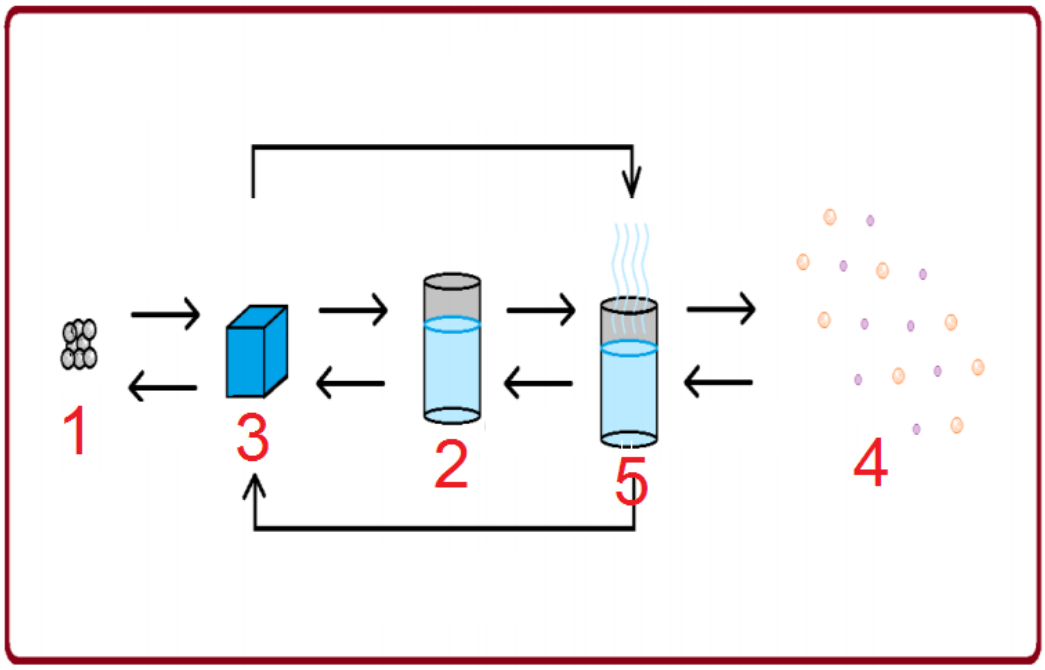
Directions: Changing things up a bit. Work on this by yourself for 50 minutes, without talking to ANYONE, using ONLY what you've learned at/by this stage of the semester and your NON-programmable calculator: NO NOTES and NO PARTNER. You may check your OWN work in office hours tonight (12/9), tomorrow between 1445 and 1545 (12/10) or Friday between 1900-2000 (12/11) for credit/check-off. There are no other office hours' times available for this required credit check.



1) Solve the following problem: $7.835 = (\ln(2.65x/3.45))$.

2) Your patient's order reads, "Crystodigin, 125 μg, IV". You have a 10 mL vial of Crystodigin that is labeled 0.5 mg/mL. How many **mL** will you give to your patient?

3) To the alchemists, Au was the material representation of purity. It is a very soft metal that can be hammered into extremely thin sheets. If a 2 gram piece of gold (ρ = 19.32 g/cc) is hammered into a sheet whose area is 20 sq ft, what is the average thickness of the sheet **in mm**?

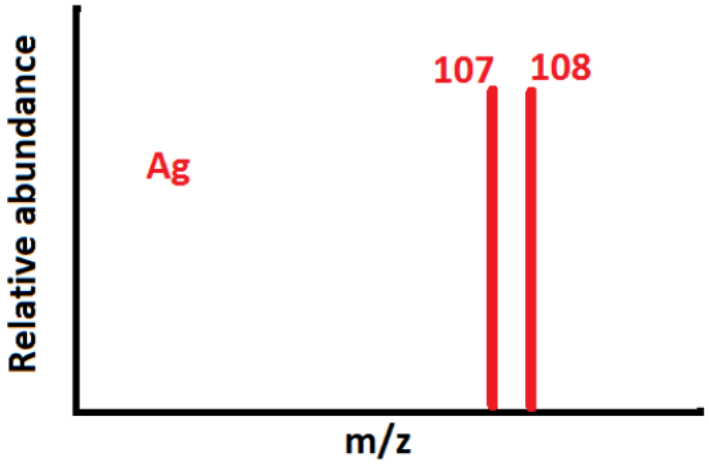


4) Label the 5 phases of matter in the image.

5) There are two isotopes of Lithium: ^{6}Li and ^{7}Li. There's 12 times as much ^{7}Li as ^{6}Li. What is the average mass of Li?

6) What are the two "magic numbers" for elements when they ionize? With which ionic form (cation or anion) do they align?

7) In the mass spectrum, qualitatively indicate the relative abundances of the isotopes for each element:



8) The N shell consists of the 4s, 4p, 4d and 4f subshells. The maximum numbers of electrons the N shell may hold is _____ electrons or _____ electrons. The maximum number of electrons ANY s subshell may hold is _____ electrons. The maximum number of electrons ANY p subshell may hold is _____ electrons. The maximum number of electrons ANY p **sub-subshell** may hold is _____ electrons. The maximum numbers a d subshell may hold is _____ electrons. The maximum number of electrons a d **sub-subshell** may hold is _____ electrons.

9) In chemistry, there is a system known as the "ous" and "ic" system of nomenclature of ions. This system is used with metallic elements that have two (2) or more ionic forms and focuses on the two (2) most common ionic forms. In this system, the ion with the lowest (least, smallest) charge has "ous" ("ous" is less") added to its stem, which may be English or Latin, depending on the metal, e.g., "ironous" doesn't "flow" – use "ferrous", instead. The ion with the highest (biggest, most) charge has "ic" ("ic" is more) added to it in the same manner as the "ous" form, e.g., copper has two common oxidation states: +1 and +2. Cu^{1+} is the cuprous ion and Cu^{2+} is the cupric ion. With that in mind, name the following ions using "ous" or "ic".

A) Fe^{2+}

B) Fe^{3+}

C) Pb^{2+}

D) Pb^{4+}

E) Zn^{2+}

F) Zn^{4+}

G) Cu^{1+}

H) Cu^{2+}

I) Hg_2^{2+} (careful with this one!)

J) Hg^{2+}

10) Given your knowledge of quantum numbers, does the following set of quantum numbers, 2, 0, -3, +½ follow the rules? Explain your response in detail.

11) There are 2 parts to this question (top of next page are the reactions you need for this question): 1) balance the following reactions and 2) identify which of these reactions is redox decomposition, non-redox decomposition, redox combination, nonredox combination, single replacement or double replacement reactions (**PS – sometimes I don't follow the rules of chemistry when I write questions for students to balance – you may have to add or remove subscripts as you solve the problems – keep an eye on your apparent charges – do you see why you need to make sure your periodic table is completed correctly?** It's a good thing you've already memorized all of those polyatomic ions from the Lewis Structures Experiment, eh?):

A) $Mg + Cl_2 \rightarrow MgCl$

B) $Na + N_2 \rightarrow NaN_3$

C) $Ba + S \rightarrow BaS$

D) $NaOH + H_2SO_4 \rightarrow NaSO_4 + H_2O$

E) $LiCO_3 + HCl \rightarrow LiCl_2 + H_2O + CO_2\uparrow$

F) $Sr(NO_3)_2 + HCl \rightarrow SrCl + HNO_3$

G) $K + H_2O \rightarrow KOH + H_2\uparrow$

H) $Al + O_2 \rightarrow Al_2O_3$

I) $MnSO_4 + HNO_3 \rightarrow Mn(NO_3)_2 + H_2SO_4$

J) $Fe + O_2 \rightarrow Fe_3O_4$

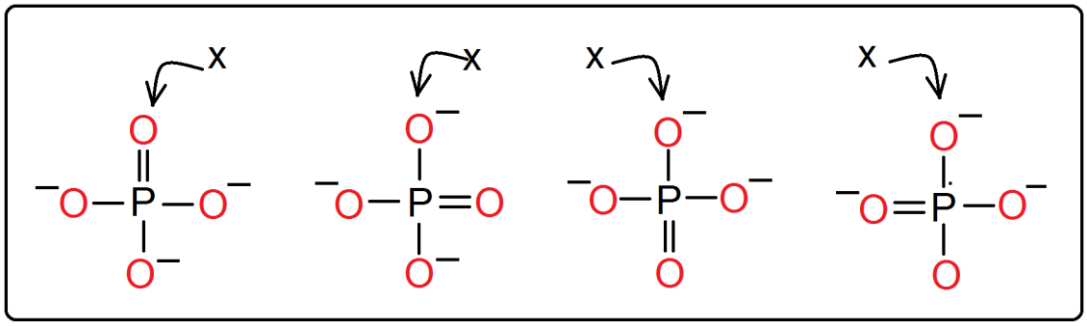
12) For the following reaction: $N_2 + 3I_2 \rightarrow 2NI_3$, if you start with 25 g I_2 and you obtain 15 g NI_3, what is the per cent yield of NI_3?

13) An aluminum pipe of 150 g is at 5°C. If the ends of this pipe are plugged after 400 g of Pb at 400°C are poured into it, what is the final temperature of the system? The specific heat capacity of Al is 0.913 J/K-g and for lead is 0.1026 J/K-g.

14) In advance of your week 10 experiment (Born Haber Cycles and Hess' Law), calculate the ΔH for the reaction CaC_2 (s) + $2H_2O$ (l) $\rightarrow$ $Ca(OH)_2$ (l) + C_2H_2 (g) given the following data:

Reaction	ΔH (kJ)
Ca(s) + ½ O2 $\rightarrow$ CaO (s)	-635.5
Ca(s) + 2C (graphite) $\rightarrow$ CaC_2 (s)	-62.8
CaO(s) + H_2O (l) $\rightarrow$ $Ca(OH)_2$ (l)	-653.1
C_2H_2 (g) + 2.5 O_2 $\rightarrow$ $2CO_2$ (g) + H_2O (l)	-1300
C(graphite) + O_2 (g) $\rightarrow$ CO_2(g)	-393.5

15) According to resonance theory, each bond in the phosphate ion (PO_4^{3-}) is consistent with the observation that the four bonds in the phosphate ion have the same bond length. Given that the P–O bond energy is 376.6 kJ/bond and that the P=O bond energy is 460.2 kJ/bond, determine the bond energy for the O labeled "X" in the diagram, below.



16) Write the chemical structures (formulas) for the following acids:

A) Bromous acid

B) Iodous acid

C) Chlorous acid

D) Flourous acid

17) Draw a diagram to explain Bernoulli's Law in the space below – be sure to label it.

18) Write out the complete and correctly balanced reaction between carbon dioxide and water, as well as the partial deprotonation of carbonic acid to a proton and bicarbonate ion. Name the reactants and the product[s].

19) Write out the formula and the Lewis structures for the following:

A) Carbonic acid

B) Nitric acid

C) Sulfuric acid

D) Phosphoric acid

20) Name the following ionic compounds.

$KMnO_4$ _____ $Al(NO_3)_3$_____

Na_2CrO_4 _____ MgO_____

AgCl _____ AlN_____

Na_2O _____$Ca_3(PO_4)_2$ _____

$NaC_2H_3O_2$_____K_3N_____

$CuSO_4$ _____LiH_2PO_4_____

$Sn(ClO)_4$_____

21) If a solution of 0.25 M HA dissociates as follows: $HA + H_2O \Leftrightarrow H^30^+ + A^-$, what is the final $[H_3O^+]$ in the solution? K_a for HA = $5.4 \cdot 10^{-7}$. What's the pH of the solution? What's the K_b of HA?

22) Determine the oxidation numbers for the following chemicals:

A) BaO

B) CaO

B) MgO

C) Na_2O

C) B_2O_3

D) SO_2

D) CO_2

E) P_2O_5

E) SO_3

F) NO

23) Determine the charge on the chemicals below:

A) Ba

B) Sr

C) N_2

D) F_2

E) Cr

F) W

G) Pd

H) Bi

I) Xe

J) Al

K) Rb

L) Sg

M) Tc

N) Y

O) Rn

24) Balance the following reaction using the first redox balancing method:

$$NO_3^- + I_2 \rightarrow IO_3^- + NO_2\uparrow$$

25) Balance the following reaction using the second redox balancing method:

$$NO_3^- + Zn \rightarrow NH_3\uparrow + Zn(OH)_4^{2-}$$

Table of Half Reactions

IMPORTANT: When necessary, turn the reactions around to fit your needs – do NOT, however, change the contents of the half-reactions

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$O_2 + 2H_2O + 2e^- \rightarrow H_2O_2 + 2OH^-$

$Zn^{2+} + 2e^- \rightarrow Zn$

$Cu^{2+} + 2e^- \rightarrow Cu$

$2IO_3^- + 12H^+ + 10\ e^- \rightarrow I_2 + 6H_2O$

$NO_3^- + 4H^+ + 3\ e^- \rightarrow NO + 2H_2O$

$ClO_3^- + 6H^+ + 6\ e^- \rightarrow Cl^- + 3H_2O$

$Cr_2O_7^{2-} + 14H^+ + 6\ e^- \rightarrow 2Cr^{3+} + 7H_2O$

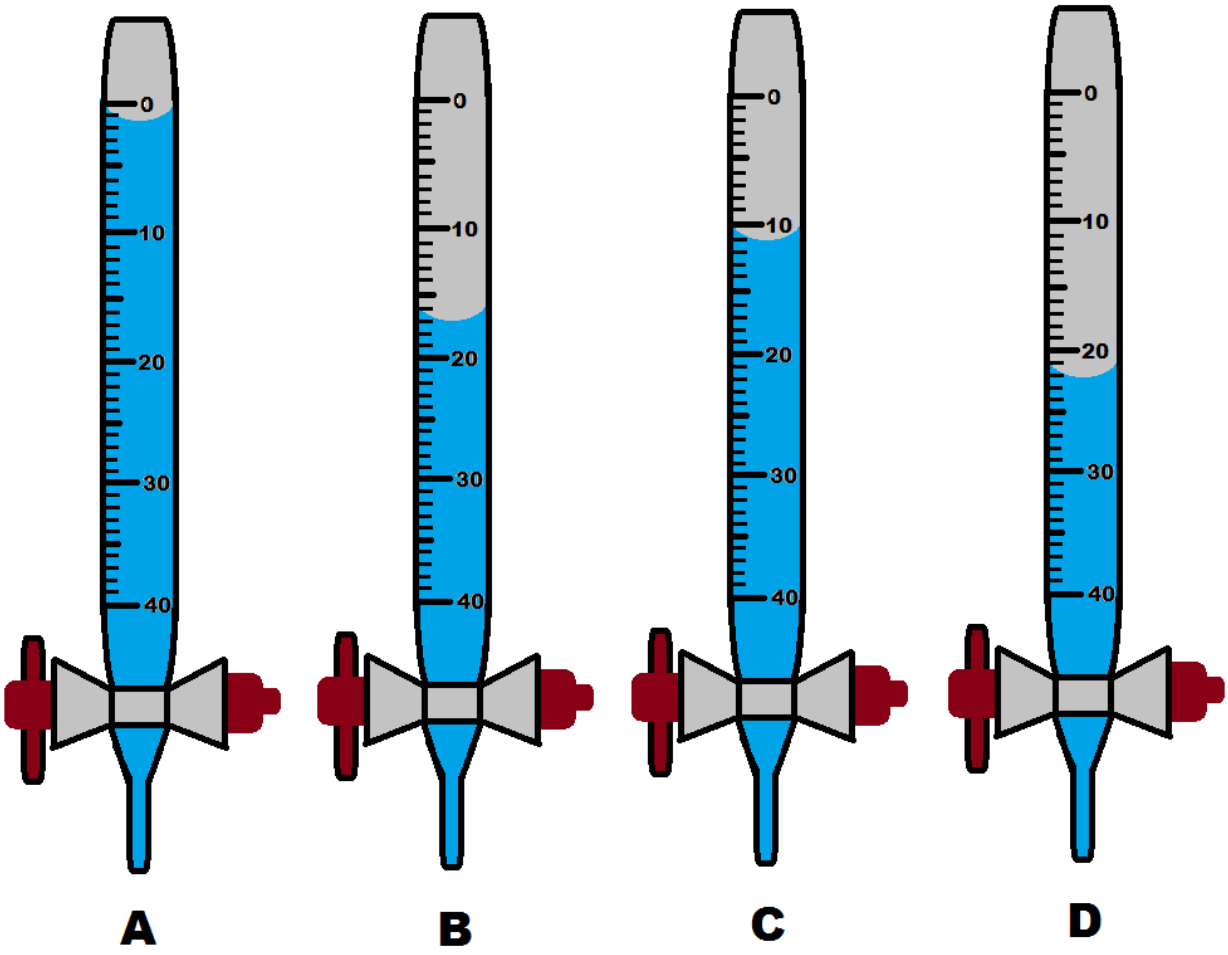
$NO_3^- + 3H^+ + 2\ e^- \rightarrow HNO_2 + H_2O$

$PbO + H_2O + 2\ e^- \rightarrow Pb + 2OH^{-1}$.

26) Balance the following reaction with the third redox balancing method:

$ClO_3^- + I_2 \rightarrow IO_3^- + Cl^-$

27) Given the following images of burets, determine the volume reading to the nearest significant figure.



28) Nitrogen has 5 valence electrons (Group V). It can gain up to 3 electrons (-3 oxidation state), or lose up to 5 (+5 oxidation state) electrons. Fill in the missing names or formulas and assign an oxidation state to each of the following nitrogen containing compounds:

name	formula	oxidation state of N
	NH_3	
nitrogen		
nitrite		
	NO_3^-	
dinitrogen monoxide		
	NO_2	
hydroxylamine	NH_2OH	
nitrogen monoxide		
hydrazine	N_2H_4	

29) Using the "out of the box" method, balance the following reaction. Show all of your work.

$$NH_3 + NO_2 \rightarrow N_2 + H_2O$$

30) Balance the following reaction by the second method (in acid): $Mn^{2+} + BiO_3^- \rightarrow MnO_4^- + Bi^{3+}$

31) Balance the following reaction by the second method (in base): $MnO_4^- + C_2O_4^{2-} \rightarrow MnO_2 + CO_2$

32) When studying bonds between atoms, the phrase "bond order" is used. The bond order is defined as the number of bonding pairs of electrons between the atoms …

Stability	Example	Structure	Number of Bonding Pairs	Energy	Bond Order
Most Stable	N_2	N≡N	3	↑Energy	3
	O_2	O=O	2		2
	O_3	O=O—O	(2+1)/2 = 1.5		1.5
Least Stable	F_2	F—F	1	↓Energy	1

… for molecules with localized bonds, i.e., the electrons don't contribute to resonance forms. Remember the bond energy problems with the resonant forms focusing on one atom as the bonds moved around, impacting the bond energy on one oxygen in previous worksheets? Note also that higher bond orders have shorter bond lengths, whereas, smaller bond orders have longer bond lengths. Do you see how this correlates with the stability as indicated in the above table? Armed with this knowledge, then, determine and illustrate the bond order of the following sets of atoms and determine which has the highest bond order; and based **only** on the bond order determine which molecule has the strongest bonds.

Hydrogen, nitrogen and chlorine

33) If the mean velocity of a gas fits the equation:

$$v = \frac{3RT}{MW}$$

Where R = 8.314 J/mol/K, MW = molecular weight of the gas, T is in Kelvins and v = the speed of a gas in m/sec, what's the average speed of the following gases, below, at 25°C? Show all of your work. Neglect units other than m/sec in your answers (NOTE: question starts with "If" …)

A. Hydrogen

B. Nitrogen

C. Oxygen

D. Fluorine

34) According to the Law of Conservation of Mass and the Law of Definite Proportions, 39 grams of potassium, 26 grams of chromium and 32 grams of oxygen will give you how many grams of potassium chromate? Write out the formula for potassium chromate, too.

Average Bond Energies (kJ/mol)

Single Bonds						Multiple Bonds	
H—H	432	N—H	391	I—I	149	C=C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O=O	495
H—Br	363	N—Cl	200			C=O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N=O	607
C—H	413	O—H	467	S—Cl	253	N=N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	S—S	266	C≡N	891
C—O	358	O—Cl	203			C=N	615
C—F	485	O—I	234	Si—Si	340		
C—Cl	339			Si—H	393		
C—Br	276	F—F	154	Si—C	360		
C—I	240	F—Cl	253	Si—O	452		
C—S	259	F—Br	237				
		Cl—Cl	239				
		Cl—Br	218				
		Br—Br	193				

*C=O(CO_2) = 799

35) Using the above table, determine the ΔE for the following reaction: $CH_3OH + C{\equiv}O \rightarrow HC_2H_3O_2$. $HC_2H_3O_2$ has the following structure: