Practice Problems for the Chem A Final Exam!

(Solutions will be posted in the hall outside of room 418 and on the website)
http://blogs.4j.lane.edu/hocken_s/

1. Make the following conversions:

a. 75 milligrams to grams

$$(75\ mg)\left(\frac{1\ g}{1000\ mg}\right) = \boxed{0.075\ g}$$

b. 6.00×10^7 micrograms (µg) to kilograms (kg)

$$(6.00\times 10^7\ \mu g)\left(\frac{1\ kg}{10^9\ \mu g}\right) = \boxed{0.0600\ kg}$$

c. 472 centimeters to feet

$$(472\ cm)\left(\frac{1\ in}{2.54\ cm}\right)\left(\frac{1\ ft}{12\ in}\right) = 15.486 \rightarrow \boxed{15.5\ ft}$$

d. 8.0 feet per minute to millimeters per hour

$$\left(\frac{8.0\ ft}{1\ minute}\right)\left(\frac{12\ in}{1\ ft}\right)\left(\frac{2.54\ cm}{1\ in}\right)\left(\frac{10\ mm}{1\ cm}\right)\left(\frac{60\ min}{1\ hr}\right) = 146304 \rightarrow \boxed{150000\ \frac{mm}{hr}}$$

e. 100. cubic inches to cubic centimeters.

$$(100.\ in^3)\left(\frac{2.54\ cm}{1\ inch}\right)^3 = 1638.71 \rightarrow \boxed{1640\ cm^3}$$

f. 14.7 pounds per square inch to kilograms per square meter. (1 pound = 453.8 grams)

$$\left(\frac{14.7\ lbs}{in^2}\right)\left(\frac{453.8\ g}{1\ lb}\right)\left(\frac{1\ kg}{1000\ g}\right)\left(\frac{1\ in}{2.54\ cm}\right)^2\left(\frac{100\ cm}{1\ m}\right)^2 = 10339.9 \rightarrow \boxed{10300\ kg/m^2}$$

g. 0.00246 square millimeters (mm^2) to square nanometers (nm^2)

$$(0.00246\ mm^2)\left(\frac{10^6\ nm}{1\ mm}\right)^2 = \boxed{2.46\times 10^9\ nm^2}$$

2. Round each calculator answer to the correct number of significant figures

a. 112.000 / 2.10 = 53.333333 -----> 53.3

b. 112.000 + 2.10 = 114.1 -----> 114.10

c. 12.5 x 16 = 200 -----> 2.0×10^2

d. 153.48 – 2.13 = 151.35 ----> 151.35

e. 0.00022 x 198 = 0.04356 -----> 0.044

f. 3335.67 / 74.126 = 45 ----> 45.000

g. 75.9762 - 73.97 = 2.0062 -----> 2.01

h. 75.97 - 73.97 = 2 -----> 2.00

3. Iridium has two common isotopes. 62.7% of Iridium ions are Ir-193 (Mass = 192.963 amu) and the remainder are Ir-191 (mass = 190.9606 amu). 100% - 62.7% = 37.3%

a. Calculate the atomic mass of iridium based on the data.

$$(0.627)(192.963) + (0.373)(190.9606) = 192.2161 \rightarrow \boxed{192.2\ amu}$$

(really only 3 SF...)

b. How many protons and neutrons are in Ir-193? p 77 n 116

c. How many protons and neutrons are in Ir-191? p 77 n 114

$$\boxed{\begin{matrix}77\\ Ir\\ 192.22\end{matrix}}$$

For **#4 and 5**, you should be able to answer all of the problems **without your blue ion sheet.** (you'll need a periodic table for some of them though.)

4. Calcium (Ca) is element #20.

a. What is the charge on a calcium atom? 0 (atoms are neutral!)

b. What is the charge on a calcium ion? +2

c. How many protons and how many electrons are in a calcium atom? p 20 e 20

d. How many protons and how many electrons are in a calcium ion? p 20 e 18

e. Which noble gas has the same number of electrons as a calcium ion? Argon (Ar)

Arsenic (As) is element #33.

f. What is the charge on an arsenic atom? 0

g. What is the charge on an arsenide ion? -3

h. How many protons and how many electrons are in an arsenic atom? p 33 e 33

i. How many protons and how many electrons are in an arsenide ion? p 33 e 36

j. Which noble gas has the same number of electrons as the arsenide ion? Krypton (Kr)

5. Give the symbol for four ions that have the same number of electrons as Neon.

N^{-3}, O^{-2}, F^{-1}, Na^{+1}, Mg^{+2}; Al^{+3} (any of these have 10 e-, like neon has)

6a. Fill out the chart:

Symbol	#protons	# neutrons	#electrons	mass#	charge	atomic #
$^{75}As^{+5}$	33	42	28	75	+5	33
$^{66}Zn^{+2}$	30	36	28	66	+2	30
$^{131}I^{-1}$	53	78	54	131	-1	53
$^{18}O^{-2}$	8	10	10	18	-2	8
^{19}F	9	10	9	19	0	9

15
P
30.9738

6b. How many protons and neutrons are in the most common isotope of phosphorus? p 15 n 16

7. Formula Writing: Fill in the missing name or formula. Classify any compounds as ionic or covalent. I C

copper (II) sulfate I $CuSO_4$	Iron (III) phosphate $FePO_4$ I	zinc phosphate $Zn_3(PO_4)_2$ I	chlorine Cl_2
N_2O_4 C dinitrogen tetroxide	C PF_5 phosphorus pentafluoride	B_2O_3 C diboron trioxide	I Al_2O_3 aluminum oxide
I Na_3PO_4 Sodium phosphate	Cl_2O_7 C dichlorine heptoxide	I $PbCO_3$ lead (II) carbonate (plumbous carbonate)	I Sn_3N_4 Tin (IV) nitride (stannic nitride)

I ammonium carbonate $(NH_4)_2CO_3$	Iron (II) carbonate I $FeCO_3$	Ag_2SO_3 I silver sulfite	SO_3 sulfur trioxide C
I ferric hydroxide $Fe(OH)_3$	C CO_2 carbon dioxide	$SiBr_4$ C silicon tetrabromide	zinc acetate I $Zn(C_2H_3O_2)_2$

C BrO bromine monoxide	Br_2O C dibromine monoxide	Helium He	nitrogen N_2	CuO I copper(II) oxide (cupric oxide)	Cu_2S I copper (I) sulfide (cuprous sulfide)

8. a. Write a balanced chemical equation for the reaction that would occur if iodine and iron reacted to form ferric iodide. Include phase subscripts and balance the reaction.

$$3\,I_{2(s)} + 2Fe_{(s)} \longrightarrow 2\,FeI_{3(s)}$$

b. What type of compound formed in this reaction? Explain how you know.

Ionic, since Fe is a metal and I_2 is a nonmetal.

c. When the iodine reacted, did it need to gain or lose electrons to form the compound? gain

d. When the iron reacted, did it need to gain or lose electrons to form the compound? lose

9. Consider the elements barium (Ba), oxygen (O_2), sulfur (S), chlorine (Cl_2), potassium (K), and neon (Ne).

a. List any pairs of elements (from the list) that could bond together covalently:

O_2 and S, S and Cl_2, O_2 and Cl_2

(pairs of nonmetals. but not including Neon since nonreactive)

b. When the covalent compounds form, what would each element need to do with its electrons to form the compound? (gain? lose? share?) They share electrons

c. List any pairs of elements (from the list) that could bond together ionically.

Ba and O_2, Ba and S, Ba and Cl_2, K and O_2, K and S, K and Cl_2

d. List the formulas of any ionic compounds that could form.

BaO, BaS, $BaCl_2$, K_2O, K_2S, KCl (balance charge!)

e. When the ionic compounds form, what would each element need to do with its electrons to form the compound? (gain? lose? share?)

Ba and K (metals) would lose e- to form cations (+)

O_2, S, and Cl_2 (nonmetals) would gain e- to form anions (-)

10. Consider the elements phosphorus (P), Fluorine (F_2), and copper (Cu).

a. If fluorine bonds with phosphorus, what will the fluorine need to lose, gain, or share electrons?

share (F_2 and P are both nonmetals so bond covalently)

b. If fluorine bonds with copper, will the fluorine need to lose, gain, or share electrons?

gain (F_2 is a nonmetal, Cu is a metal, so they'll bond ionically)

11. a. Which can more commonly form ions with an "ide" ending: metals or [✓ nonmetals]?

b. Explain why, in terms of how metals and nonmetals change their numbers of electrons when they form ions.

If an ion ends in "ide" (or "ate" or "ite") then it must have a negative charge. metals tend to form positive ions. nonmetals tend to form negative ions, so could have the "ide" ending.

12. Moles! Make the following conversions.

a. 3.08×10^{22} iron atoms to moles

$$(3.08\times10^{22}\text{ atoms})\left(\frac{1\text{ mole}}{6.02\times10^{23}\text{ atoms}}\right) = 0.05116 \rightarrow \boxed{0.0512\text{ moles}}$$

b. 3.32 grams of hydrogen gas to moles

$$(3.32\text{ g }H_2)\left(\frac{1\text{ mole}}{2.0158\text{g}}\right) = \boxed{1.65\text{ moles }H_2}$$

c. 10.0 moles of carbon dioxide to grams

$$(10.0\text{ moles }CO_2)\left(\frac{44.0098\text{g}}{1\text{mole}}\right) = 440.098 \rightarrow \boxed{440.\text{ g}}$$

d. 3.2×10^{20} molecules of carbon dioxide to grams.

$$(3.2\times10^{20}\text{ molecules})\left(\frac{1\text{mole}}{6.02\times10^{23}\text{ molecules}}\right)\left(\frac{44.0098\text{g}}{1\text{mole}}\right) = \boxed{0.023\text{ g}}$$

e. 3.2×10^{20} molecules of carbon dioxide to atoms.

$$(3.2\times10^{20}\text{ molecules})\left(\frac{3\text{ atoms}}{1\text{ molecule}}\right) = \boxed{9.6\times10^{20}\text{ atoms }CO_2}$$

f. 24 grams of iron to atoms.

$$(24\text{ g Fe})\left(\frac{1\text{mole}}{55.845\text{g}}\right)\left(\frac{6.02\times10^{23}\text{ atoms}}{1\text{mole}}\right) = \boxed{2.6\times10^{23}\text{ atoms}}$$

g. 16.2 grams of nitrogen triiodide to molecules.

$$(16.2\text{g }NI_3)\left(\frac{1\text{mole}}{394.7202\text{ g}}\right)\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mole}}\right) = \boxed{2.47\times10^{22}\text{ molecules}}$$

h. 0.0121 moles of nitrogen triiodide to molecules.

$$(0.0121\text{ moles})\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mole}}\right) = \boxed{7.28\times10^{21}\text{ molecules}}$$

i. 0.0121 moles of nitrogen triiodide to atoms.

$$(0.0121\text{ moles})\left(\frac{6.02\times10^{23}\text{ molecules}}{1\text{mole}}\right)\left(\frac{4\text{ atoms}}{1\text{molecule}}\right) = \boxed{2.91\times10^{22}\text{ atoms}}$$

$$2(14.0067) + 8(1.0079) + 1(32.065) = 68.1416 \text{ amu}$$

13. a. Determine the percent composition of each element in $(NH_4)_2S$.

$$\% N = \frac{2(14.0067)\text{amu}}{68.1416\text{ amu}} \times 100 = \boxed{41.111\ \%\ N}$$

$$\% S = \frac{32.065\text{ amu}}{68.1416\text{amu}} \times 100 = \boxed{47.056\ \%\ S}$$

$$\% H = \frac{8(1.0079)\text{amu}}{68.1416\text{ amu}} \times 100 = \boxed{11.833\ \%\ H}$$

b. How many grams of nitrogen are in 20.0 grams of ammonium sulfide?

$$\frac{41.111}{100} = \frac{x}{20.0g} \qquad x = \boxed{8.22\text{ g nitrogen}}$$

c. What mass of carbon is in 15.0 grams of glucose sugar ($C_6H_{12}O_6$)?

$$\% C = \frac{6(12.011)}{180.1572} \times 100 = 40.0017\ \% \qquad \frac{40.0017}{100} = \frac{x}{15.0g} \qquad x = \boxed{6.00\text{ grams C}}$$

d. If you needed to extract 20.0 kg iron from iron III oxide, what mass of iron III oxide would you start with?

$$Fe_2O_3 : \ \% Fe = \frac{2(55.845)}{159.6882} \times 100 = 69.943\ \%\ Fe$$

$$\frac{69.943}{100} = \frac{20.0\text{kg}}{x} \qquad x = \boxed{28.6\text{ kg } Fe_2O_3}$$

14. a. What is the empirical formula of $C_8H_{12}O_4$? of $C_{25}H_{30}$? of $C_6H_{12}O_6$?

$$\boxed{C_2H_3O} \quad \boxed{C_5H_6} \quad \boxed{CH_2O}$$

b. A compound with a molar mass of roughly 80 amu is 85.7% carbon (by weight), and the remainder is hydrogen. Find the empirical formula and the molecular formula.

100 - 85.7 = 14.3 % H. Assume I have 100g.

$$(85.7 g\ C)\left(\frac{1\text{mole}}{12.011g}\right) = 7.1351 \text{ moles C} \qquad \frac{7.1351}{7.1351} = 1$$

$$(14.3 g\ H)\left(\frac{1\text{mole}}{1.0079g}\right) = 14.1879 \text{ moles H} \qquad \frac{14.1879}{7.1351} = 1.988 \approx 2$$

$$\rightarrow \boxed{CH_2 \text{ empirical formula}}$$

CH_2 is the empirical formula so the empirical mass ≈ 14 amu

$$\frac{80}{14} = 5.7 \rightarrow 6 \qquad 6(CH_2) = \boxed{C_6H_{12} \text{ Molec. formula}}$$

c. A compound is 26.6 %potassium, 35.3% chromium, and 38.1% oxygen by mass. Find the empirical formula. (Assume 100 g)

$$(26.6\ g\ K)\left(\frac{1\text{mole}}{39.0983g}\right) = 0.68034 \text{ moles K} \qquad \frac{0.68034}{0.6789} = 1.002 \approx 1$$

$$(35.3\ g\ Cr)\left(\frac{1\text{mole}}{51.996g}\right) = 0.6789 \text{ moles Cr} \qquad \frac{0.6789}{0.6789} = 1$$

$$(38.1\ g\ O)\left(\frac{1\text{mole}}{15.9994g}\right) = 2.3813 \text{ moles O} \qquad \frac{2.3813}{0.6789} = 3.508 \approx 3\tfrac{1}{2}$$

$$(K_1Cr_1O_{3\frac{1}{2}})(2) = \boxed{K_2Cr_2O_7}$$

(#14)

d. A compound is 46.6 % C, 6.84 % H, and 46.5% oxygen by mass. Calculate the empirical formula.

$(46.6g\ C)\left(\frac{1mole}{12.011g}\right) = 3.8798$ moles C $\qquad \frac{3.8798}{2.9064} = 1.3349 \approx 1\frac{1}{3}$

$(6.84\ g H)\left(\frac{1mole}{1.0079g}\right) = 6.7864$ moles H $\qquad \frac{6.7864}{2.9064} = 2.3349 \approx 2\frac{1}{3}$

$(46.5g\ O)\left(\frac{1mole}{15.9994g}\right) = 2.9064$ moles O $\qquad \frac{2.9064}{2.9064} = 1$

$(C_{1\frac{1}{3}}H_{2\frac{1}{3}}O)(3) = \boxed{C_4H_7O_3}$

e. The compound in (d) has a molar mass between 400 and 450 g/mole. Find the molecular formula.

$C_4H_7O_3$ empirical mass is ≈ 103 amu $\qquad 4(C_4H_7O_3) = \boxed{C_{16}H_{28}O_{12}}$

$\frac{400}{103} = 3.88 \qquad \frac{450}{103} = 4.37$

f. A compound contains 8.68 grams of carbon per 1.18 grams hydrogen and 2.54 grams nitrogen. Calculate the empirical formula of the compound.

$(8.68g\ C)\left(\frac{1mole}{12.011\ g}\right) = 0.72267$ moles C $\qquad \frac{0.72267}{0.18134} = 3.99 \approx 4$

$(1.18g\ H)\left(\frac{1mole}{1.0079\ g}\right) = 1.1708$ moles H $\qquad \frac{1.1708}{0.18134} = 6.46 \approx 6\frac{1}{2}$

$(2.54g\ N)\left(\frac{1mole}{14.0067g}\right) = 0.18134$ moles N $\qquad \frac{.18134}{.18134} = 1$

$(C_4H_{6\frac{1}{2}}N_1)(2) = \boxed{C_8H_{13}N_2}$

15. A crucible containing copper powder is heated until the copper oxidizes to form copper oxide. The following data is obtained:

Mass of crucible: 26.000 g
Mass of crucible and copper powder (before reaction): 27.021 g
Mass of crucible and copper oxide product (after reaction): 27.272 g

a. Determine these masses:

the mass of copper powder, before the reaction: 27.021g − 26.000g = $\boxed{1.021g\ Cu}$

the mass of copper oxide that formed: 27.272g − 26.000g = $\boxed{1.272g\ \text{copper oxide}}$

the mass of oxygen that bonded with copper: 1.272g − 1.021g = $\boxed{0.251\ g}$ OR 27.272 − 27.021 = $\boxed{0.251\ g}$

b. What is the percent oxygen in the copper oxide product?

$(0.251g / 1.272g) \times 100 = 19.733 \rightarrow \boxed{19.7\%\ \text{oxygen}}$

c. Was the product copper (I) oxide or copper (II) oxide? (which one)

Copper I oxide: Cu_2O

$\%O = \frac{15.9994\ amu}{143.0914\ amu} \times 100 = 11.181\%\ O$

Copper II oxide: CuO $\qquad \%O = \frac{15.9994\ amu}{79.5454\ amu} \times 100 = 20.114\%$

It was probably Copper II oxide (CuO) since the % was closer.

16. An experiment was done to determine the percent iron in iron (III) sulfate. Some solid iron (III) sulfate was dissolved into water, and then was reacted with Zinc in a single replacement reaction. The iron that formed was washed, dried, and weighed, and the following data was obtained.

Mass of empty beaker: 54.44 g
Mass of beaker and solid iron (III) sulfate: 58.84 grams
Mass of empty evaporating dish: 42.21 grams
Mass of evaporating dish and iron powder that formed: 43.47 grams

58.84 g - 54.44 g = $\underline{4.40\ g}$ iron III sulfate

43.47g - 42.21g = $\underline{1.26\ g}$ iron

a. Use the lab data to calculate the percent iron in iron (III) sulfate.

$$\% Fe = \frac{\text{mass Fe}}{\text{mass iron III sulfate}} \times 100 = \frac{1.26g}{4.40g} \times 100 = 28.6364 \rightarrow \boxed{28.6 \% Fe}$$

b. Write the formula for iron (III) sulfate.

$$Fe^{+3} / SO_4^{-2} \rightarrow \boxed{Fe_2(SO_4)_3}$$

c. Use your formula to calculate the book value for the percent iron in this compound.

$$\% Fe = \frac{2(55.845)\text{amu}}{399.8778\text{ amu}} \times 100 = 27.93103 \rightarrow \boxed{27.931 \% Fe}$$

d. What was the percent error for the experiment?

$$\% \text{error} = \left| \frac{\text{lab} - \text{book}}{\text{book}} \right| \times 100 = \left| \frac{28.6364 - 27.93103}{27.93103} \right| \times 100 = \frac{0.70537}{27.93103} \times 100$$

$$= 2.5254 \rightarrow \boxed{3 \%}$$

e. Write a balanced reaction for zinc reacting with the iron (III) sulfate, with phase subscripts.

$$\boxed{3 Zn_{(s)} + Fe_2(SO_4)_{3(aq)} \longrightarrow 3 ZnSO_{4(aq)} + 2Fe_{(s)}}$$

17. Reactions! Predict products for each reaction. A few are N.R. Do phase subscripts and balancing.

a. 3 Ca (s) + N_2 (g) ------> $Ca_3N_2\ (s)$

b. 2 $FeCl_3$ (aq) + 3 Ag_2SO_4(aq) ------> $Fe_2(SO_4)_{3(aq)} + 6AgCl_{(s)}$

c. 2 Al (s) + 3 $Ni(NO_3)_2$(aq) ------> $2Al(NO_3)_{3(aq)} + 3Ni_{(s)}$

16+10=26

d. 2 C_4H_{10} (l) + $\overset{13}{\vee}$ O_2 (g) ------> $8CO_{2(g)} + 10H_2O_{(g)}$

e. 6 HNO_3(aq) + 2 Al (s) ------> $2Al(NO_3)_{3(aq)} + 3H_{2(g)}$

(#17)

f. 6 H_2O (l) + 2 Al (s) + ------> $2\ Al(OH)_{3(s)} + 3\ H_{2(g)}$

40 + 16 = 56

g. 2 $C_{10}H_{16}O$ (l) + 27 O_2 (g) ------> $20\ CO_{2(g)} + 16\ H_2O_{(g)}$

h. 2 HCl(aq) + Li_2CO_3(aq) ------> ~~H_2CO_3~~ $H_2O_{(l)} + CO_{2(g)} + 2\ LiCl_{(aq)}$

i. 4 K(s) + O_2 (g) ------> $2\ K_2O_{(s)}$

j. 3 F_2 (g) + 2 $FeCl_3$(aq) ------> * $2\ FeF_{3(s)} + 3\ Cl_{2(g)}$

* FeF_3 isn't actually on your solubility chart, sorry.

k. 2 C_3H_7OH (l) + 9 O_2 (g) ------> $6\ CO_{2(g)} + 8\ H_2O_{(g)}$

12 + 8 = 20

l. Zn (s) + $Al(NO_3)_3$(aq) ------> N.R.

m. 2 H_2O (l) + 2 Li (s) + ------> $2\ LiOH_{(aq)} + H_{2(g)}$

n. P(s) + 3 Na(s) ------> $Na_3P_{(s)}$

o. I_2 (s) + NaCl (aq)------> N.R.

p. $Al(NO_3)_3$ (aq) + NaCl (aq) ------> ~~$AlCl_{3(aq)} + NaNO_{3(aq)}$~~ N.R.

q. 2 HCl(aq) + $Ba(OH)_2$ (aq) ------> $2\ H_2O_{(l)} + BaCl_{2(aq)}$

r. $FeCl_3$ (aq) + 3 $AgNO_3$(aq) ------> $Fe(NO_3)_{3(aq)} + 3\ AgCl_{(s)}$

s. $Pb(NO_3)_4$(aq) + 2 Zn (s) ------> $2\ Zn(NO_3)_{2(aq)} + Pb_{(s)}$

t. Pb (s) + H_2O (l) ------> N.R.

u. 2 Al (s) + 6 $HC_2H_3O_2$(aq) ------> $2\ Al(C_2H_3O_2)_{3(aq)} + 3\ H_{2(g)}$

v. 2 HNO_3(aq) + $MgCO_3$ (s) ------> $H_2O_{(l)} + CO_{2(g)} + Mg(NO_3)_{2(aq)}$

w. 2 $Al(NO_3)_3$ + 3 Li_2CO_3(aq) ------> $Al_2(CO_3)_{3(s)} + 6\ LiNO_{3(aq)}$

x. 2 K(s) + Cl_2 (g) -------> $2\ KCl_{(s)}$

y. N_2 (g) + 6 Na(s) ------> $2\ Na_3N_{(s)}$

z. C_9H_{20} (l) + 14 O_2 (g) ------> $9\ CO_{2(g)} + 10\ H_2O_{(g)}$

18 + 10 = 28

18. $3\,Zn_{(s)} + 7\,H_2SO_{4(aq)} + K_2Cr_2O_{7(aq)} \text{ -----> } Cr_2(SO_4)_{3(aq)} + 7\,H_2O_{(l)} + 3\,ZnSO_{4(aq)} + K_2SO_{4(aq)}$

a. If 10.0 grams of H_2SO_4 react, what mass of zinc sulfate will be produced?

$$(10.0g\ H_2SO_4)\left(\frac{1mole}{98.0784g}\right)\left(\frac{3mole\ ZnSO_4}{7\ mole\ H_2SO_4}\right)\left(\frac{161.4426g}{1mole}\right) = 7.0545 \rightarrow \boxed{\begin{array}{c}7.05g\\ ZnSO_4\end{array}}\ (a)$$

b. If 6.55 grams of zinc sulfate are collected in (a), what was the percent yield?

$$\%\ yield = \frac{actual}{expected} \times 100 = \frac{6.55g}{7.0545g} \times 100 = 92.848 \rightarrow \boxed{92.8\ \%}\ (b)$$

c. How many moles of H_2SO_4 are needed to produce 0.211 moles of chromium sulfate?

$$\left(0.211\ moles\ Cr_2(SO_4)_3\right)\left(\frac{7mole\ H_2SO_4}{1\ mole\ Cr_2(SO_4)_3}\right) = \boxed{1.48\ moles\ H_2SO_4}\ (c)$$

d. How many water molecules will form, if ~~1.1 x 10^{21} zinc atoms react?~~ 0.0201 moles Zn react?

$$(0.0201\ moles\ Zn)\left(\frac{7\ mole\ H_2O}{3\ mole\ Zn}\right)\left(\frac{6.02\times10^{23}\ molecules}{1mole}\right) = \boxed{\begin{array}{c}2.82\times10^{22}\\ molecules\ H_2O\end{array}}\ (d)$$

e. How many moles of H_2SO_4 must react in order to form 0.34 moles of potassium sulfate?

$$(0.34\ moles\ K_2SO_4)\left(\frac{7\ mole\ H_2SO_4}{1\ mole\ K_2SO_4}\right) = 2.38 \rightarrow \boxed{\begin{array}{c}2.4\ moles\\ H_2SO_4\end{array}}\ (e)$$

19. $2\,Fe_{(s)} + 6\ HCl_{(aq)} \text{ -------> } 2\,FeCl_{3(aq)} + 3\,H_{2(g)}$

a. If 50.0 grams of iron are allowed to react with 85.0 grams of HCl, how many grams of iron chloride can form?

$$(50.0g\ Fe)\left(\frac{1mole}{55.845g}\right)\left(\frac{2mole\ FeCl_3}{2mole\ Fe}\right)\left(\frac{162.204\ g}{1mole}\right) = 145\cancel{.23}\,g$$

$$(85.0g\ HCl)\left(\frac{1mole}{36.4609g}\right)\left(\frac{2mole\ FeCl_3}{6\ mole\ HCl}\right)\left(\frac{162.204\ g}{1mole}\right) = 126.05 \rightarrow \boxed{\begin{array}{c}126g\\ FeCl_3\end{array}}\ (a)$$

b. If 1.0 x 10^{23} iron atoms are allowed to react with 22.0 grams of acid, how many moles of hydrogen gas can form?

$$(1.0\times10^{23}\ Fe\ atoms)\left(\frac{1mole}{6.02\times10^{23}atoms}\right)\left(\frac{3mole\ H_2}{2\ mole\ Fe}\right) = 0.2492\ moles$$

$$(22.0g\ HCl)\left(\frac{1mole}{36.4609\ g}\right)\left(\frac{3\ mole\ H_2}{6\ mole\ HCl}\right) = 0.3\cancel{017}\ moles$$

$$(b)\ \boxed{\begin{array}{c}0.25\ moles\\ H_2\ can\\ form.\end{array}}$$

c. If 0.10 moles of iron are allowed to react with 14.2 grams of acid, what mass of hydrogen gas can form?

$$(0.10\ moles\ Fe)\left(\frac{3\ mole\ H_2}{2\ mole\ Fe}\right)\left(\frac{2.0158g}{1mole}\right) = 0.30237\ g \rightarrow \boxed{\begin{array}{c}0.30\ grams\\ H_2\end{array}}\ (c)$$

$$(14.2g\ HCl)\left(\frac{1mole}{36.4609\ g}\right)\left(\frac{3mole\ H_2}{6\ mole\ HCl}\right)\left(\frac{2.0158g}{1mole}\right) = 0.3\cancel{92}5\,g$$

19, continued. $2\ Fe_{(s)} + 6\ HCl_{(aq)} \text{ -------> } 2\ FeCl_{3(aq)} + 3\ H_{2(g)}$

Suppose that a 0.100 mole piece of iron is placed into a solution containing 0.200 moles of hydrochloric acid, and is left alone for a few days.

d. When the reaction is done, how many moles of hydrogen gas should have formed?

$(0.100 \text{ mole Fe})\left(\frac{3 \text{ mole } H_2}{2 \text{ mole Fe}}\right) = \cancel{0.150} \text{ mole } H_2$

$(0.200 \text{ mole HCl})\left(\frac{3 \text{ mole } H_2}{6 \text{ mole HCl}}\right) = 0.100 \text{ mole } H_2$

So, 0.100 mole H_2 can form.
Fe is the excess reactant
HCl is the Limiting reactant

e. What one of these shows reasonable values for the amounts of Fe and HCl that are leftover after the rxn? You should be able to choose the right answer without doing any more math.

a. 0.000 moles of iron, and ~~0.150 moles of HCl~~

b. 0.000 moles of iron, and ~~0.250 moles of HCl~~

These two dont work: Since HCl is limiting, HCl should be the one with none leftover

c. ~~0.133 moles of iron~~, and 0.000 moles of HCl

[✓ d.] 0.033 moles of iron, and 0.000 moles of HCl

these 2 could work since no HCl remains

but (c) doesnt work since there is more Fe than we started with! (.133 > .100)

20. a. Calculate the molarity of a solution that contains 5.48 grams of $CaBr_2$ per 425 mL solution.

$\text{Molarity} = \frac{\text{moles solute}}{\text{Liters solution}} = \frac{(5.48g)\left(\frac{1 \text{ mole}}{199.888g}\right)}{0.425 \text{ L}} = 0.06451 \rightarrow \boxed{0.0645 \text{ M } CaBr_2}$

b. What mass of LiCl must be dissolved, in order to make 1450 mL of 0.400 Molar LiCl?

$\left(0.400 \frac{\text{mole}}{\text{L}}\right)(1.45 \text{ L})\left(\frac{42.394g}{1 \text{mole}}\right) = 24.589 \rightarrow \boxed{24.6 \text{ g LiCl}}$

c. If a solution contains 0.292 moles of LiCl per 150. mL solution, what is the molarity?

$\frac{0.292 \text{ moles}}{0.150 \text{ L}} = \boxed{1.95 \text{ M}} \text{ LiCl}$

d. How many moles of $CaBr_2$ would be required to make 200. mL of 0.350 M $CaBr_2$ solution?

$(0.200 \text{ L})\left(\frac{0.350 \text{ mole}}{1 \text{ L}}\right) = \boxed{0.0700 \text{ moles } CaBr_2}$

e. What is the molarity of a solution containing 10.0 grams $C_6H_{12}O_6$ per 50.0 mL solution volume?

$\frac{(10.0g\ C_6H_{12}O_6)\left(\frac{1 \text{mole}}{180.1572g}\right)}{0.0500 \text{L}} = \boxed{1.11 \text{ M}}$

f. Which of the $CaBr_2$ solutions (above) was more dilute? (a) (.0645 M) Which was more concentrated? (d) (0.350 M)

(a) was .0645 M $CaBr_2$
(d) was 0.350 M

21. An experiment was done to determine molarity of a hydrochloric acid solution (HCl). The solution of hydrochloric acid is added to some zinc wire in a beaker, and is allowed to react for several days. The zinc wire that remains after the reaction is washed, dried, and weighed. The same beaker was used throughout the experiment, and the following data was obtained:

Volume of acid used (measured by grad. cylinder): 60.0 mL
Mass of empty beaker: 52.00 g
Mass of beaker and zinc wire (before the reaction): 58.33 grams
Mass of beaker and zinc wire (after drying in the oven): 56.77 grams

a. Write the reaction that occurred between zinc and hydrochloric acid. Include subscripts.

$$\boxed{Zn_{(s)} + 2\,HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}}$$

b. Determine the mass of zinc that was consumed by the reaction with HCl.

$$58.33\,g - 56.77\,g = \boxed{1.56\,g\ Zn\ \text{consumed}}$$

c. Use stoichiometry to determine the moles of HCl required to react with the mass of zinc calculated in (b).

$$(1.56\,g\ Zn)\left(\frac{1\,mole}{65.38\,g}\right)\left(\frac{2\ mole\ HCl}{1\ mole\ Zn}\right) = 0.047721 \rightarrow \boxed{0.0477\ \text{moles of}\ HCl}$$

d. Calculate the molarity of the HCl solution.

$$\frac{0.047721\ moles}{0.0600\ L} = 0.795\ \frac{mole}{L} \rightarrow \boxed{0.795\ M}$$

e. What would be a sign that the reaction was complete.. how would the contents of the beaker look when the HCl was first added, vs how would it look after the reaction was done?

when the HCl is first added, the rxn will be producing H_2 (gas), so there will be fizz/bubbles forming on the Zn wire and rising up. once the rxn is done, no more bubbles will be forming.

f. Which substance was the limiting reactant in this experiment?

$\boxed{HCl}$ Once the rxn was complete, there was still some zinc leftover. so Zn is the excess reactant, and HCl is the limiting reactant.

22. For each atom or ion:
a. Write the electron configuration.
b. Underline the valence electrons, and indicate the number of valence electrons it has.

#95 Am	$[Rn]\underline{7s^2}5f^7$	2 v.e.	#85 At	$[Xe]\underline{6s^2}4f^{14}5d^{10}\underline{6p^5}$	7 v.e.
#55 Cs	$[Xe]\underline{6s^1}$	1 v.e.	#12 Mg	$1s^2 2s^2 2p^6 \underline{3s^2}$ ($[Ne]3s^2$)	2 v.e.
#32 Ge	$[Ar]\underline{4s^2}3d^{10}\underline{4p^2}$	4 v.e.	magnesium ion	$Mg^{+2}: 1s^2\underline{2s^2 2p^6}$	8 v.e.

#35 Br $[Ar]4s^2 3d^{10} 4p^5$ 7 v.e.

#16 S $[Ne]3s^2 3p^4$ 6 v.e.

#6 C $1s^2 2s^2 2p^2$ $([He]2s^2 2p^2)$ 4 v.e.

bromide ion (Br^{-1}) $[Ar]4s^2 3d^{10} 4p^6$ 8 v.e.

sulfide ion (S^{-2}) $[Ne]3s^2 3p^6$ 8 v.e.

Nb #41 $[Kr]5s^2 4d^3$ 2 v.e.

c. Give the formula for 3 other ions (include at least 1 cation and 1 anion) that have the same number of electrons as bromide ion.

As^{-3} Se^{-2} Rb^{+1} Sr^{+2} Y^{+3} Zr^{+4} (all have 36 electrons)

d. Give the formula for 3 ions (include at least 1 cation and 1 anion) that have the same number of electrons as Xenon.

Te^{-2} I^{-1} Cs^{+1} Ba^{+2} La^{+3} (all have 54 electrons)

23. For each pair, which "thing" has more energy?
(assume that the electrons mentioned are in the same type of element.)

a. [✓ An electron in a 4s orbital] or An electron in a 3s orbital

b. [✓ EM radiation with a frequency of 1.21 x10^{14} Hz.] or with a frequency of 8.21 x10^{13} Hz.

c. An electron in a 5s orbital or [✓ An electron in a 5f orbital]

d. EM radiation with a wavelength of 1774 nm or [✓ with a wavelength of 344 nm.]

e. yellow light or [✓ green light]

f. [✓ An electron that is 0.2 nm away from the nucleus,] or an electron that is 0.08 nm away from the nucleus.

g. a radio wave or [✓ an infrared wave]

h. [✓ ultraviolet radiation] or microwave radiation

24. For each pair, indicate whether they are attracted to or repelled by each other, and explain your answer.

a. the nucleus and an electron attracted. The nucleus is positively charged and the e- are negatively charged. opposite charges attract.

b. an electron and another electron repelled. all e- are negative. same charges repel.

c. an electron and a proton

attracted. e- are negative. protons are positive. opposite charges attract.

25. Use your answer(s) to #24 to explain why higher n-level has higher/lower (which one?) potential energy.

As n-level increases, the e- in the n-level are further away from the nucleus. The electrons are negatively charged and the nucleus is positively charged, so the electrons are attracted to the nucleus. Therefore the e- will need to increase energy to become further away from the nucleus and increase n-level.

26a. Determine the frequency of EM radiation with a photon energy of 6.99 x 10^{-26} J.

$E = h\nu$

$$\nu = \frac{E}{h} = \frac{6.99\times10^{-26}\,J}{6.63\times10^{-34}\,J{\cdot}s} = \boxed{1.05\times10^{8}\,Hz}$$

or $\boxed{1.05\times10^{8}\,s^{-1}}$

b. Determine the photon energy of EM radiation with a wavelength of 4.1 nm.

$$(4.1\,nm)\left(\frac{1m}{10^{9}\,nm}\right) = 4.1\times10^{-9}\,m$$

$c = \lambda\nu$

$$\nu = \frac{c}{\lambda} = \frac{3.00\times10^{8}\,\frac{m}{s}}{4.1\times10^{-9}\,m} = 7.317\times10^{16}\,s^{-1}$$

or Hz

$$E = h\nu = (6.63\times10^{-34}\,J{\cdot}s)(7.317\times10^{16}\,s^{-1})$$

$$E = 4.851\times10^{-17}\,J$$

$$\boxed{4.9\times10^{-17}\,J}$$

c. Find the wavelength, in nm, of EM radiation with a frequency of 1.21 x10^{14} Hz.

$c = \lambda\nu$

$$\lambda = \frac{c}{\nu} = \frac{3.00\times10^{8}\,m/s}{1.21\times10^{14}\,s^{-1}} = 2.479\times10^{-6}\,m$$

$$(2.479\times10^{-6}\,m)\left(\frac{10^{9}\,nm}{1m}\right) = 2479\,nm \rightarrow \boxed{2480\,nm}$$

d. Find the frequency of EM radiation with a wavelength of 5.8 x 10^{-6} meters.

$c = \lambda\nu$

$$\nu = \frac{c}{\lambda} = \frac{3.00\times10^{8}\,m/s}{5.8\times10^{-6}\,m} = 5.172\times10^{13}\,s^{-1} \rightarrow \boxed{5.2\times10^{13}\,s^{-1}}$$

or $\boxed{5.2\times10^{13}\,Hz}$

e. Find the wavelength of EM radiation with a photon energy of 7.18 x 10^{-18} J.
Report your answer in m and nm.

$E = h\nu$

$$\nu = \frac{E}{h} = \frac{7.18\times10^{-18}\,J}{6.63\times10^{-34}\,J{\cdot}s} = 1.0829\times10^{16}\,s^{-1}$$

or Hz

$c = \lambda\nu$

$$\lambda = \frac{c}{\nu} = \frac{3.00\times10^{8}\,m/s}{1.0829\times10^{16}\,s^{-1}} = \boxed{2.77\times10^{-8}\,m}$$

$$(2.77\times10^{-8}\,m)\left(\frac{10^{9}\,nm}{1m}\right) = \boxed{27.7\,nm}$$

C Li Bk Zr B Pb P Br Ba Ni Au Xe W Sm Se K

27. Choose from the above list of elements to answer the questions below.

An element with 5 valence electrons. P (column V A)

An element with 7 valence electrons. Br (column VII A ; halogens)

An element in the same family as magnesium. Ba

An element in the same period as magnesium. P

A halogen. Br

An alkali earth metal. Ba

A metal with 4 valence electrons. Pb

column IV A

A nonmetal with 4 valence electrons. C

An element with an electron configuration ending in p^3. P column VA

An alkali metal. Li or K

An actinide. BK

A lanthanide. Sm

An element with partially filled f-orbitals. BK or Sm

An element with partially filled d-orbitals. Zr, Ni, Au, W (any transition metal)

A representative element. C, Li, B, Pb, P, Br, Ba, Xe, Se, K

A transition metal. Zr, Ni, Au, W

A noble gas. Xe

An inner transition metal. BK or Sm

An element with 1 valence electron. Li or K (column I A)

An element with 3 valence electrons. B (column III A)

An element with 8 valence electrons. Xe

An element in the same family as oxygen. Se

An element with an electron configuration ending in p^6. Xe (any noble gas except He)

An element with an electron configuration ending in d^2. Zr

An element that tends to form a +1 ion. Li or K

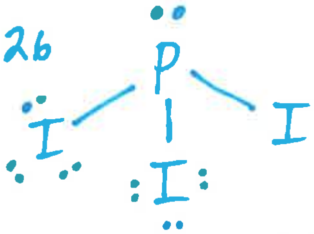
An element that is completely inert (non-reactive.) Xe

An element that tend for form ions by gaining 2 electrons. Se

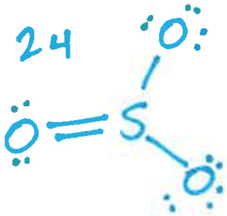
An element that tends to form ions by gaining 1 electron. Br

28. a. Draw the Lewis dot structure for each of these.

PI_3 26



SO_3 24

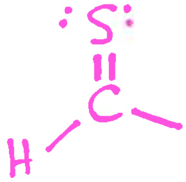


HOBr (O is the central atom)

14

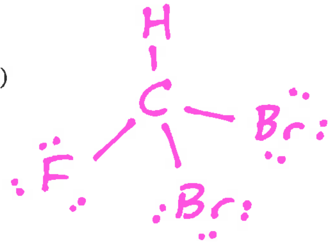
CH_2S
(C is the central atom)

12

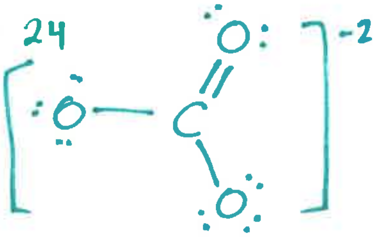


$CFBr_2H$
(C is the central atom)

26

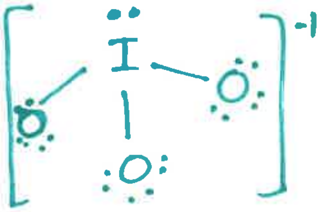


CO_3^{-2} 24



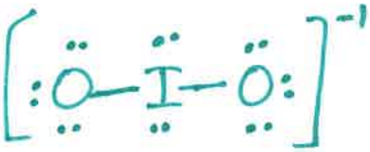
IO_3^{-1}

26



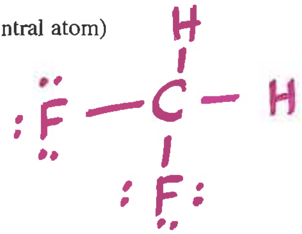
IO_2^{-1}

20



CF_2H_2
(C is the central atom)

20



SO_2

18

NO_2^{+1}

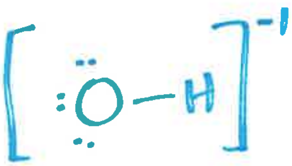
16

OF_2

20

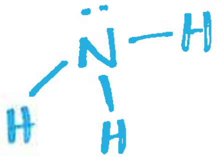
OH^{-1}

8



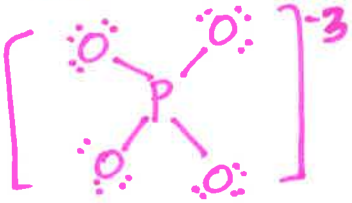
NH_3

8



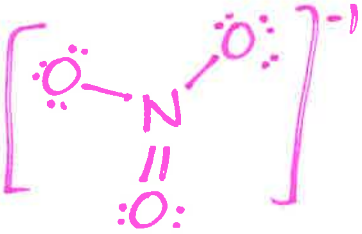
PO_4^{-3}

32



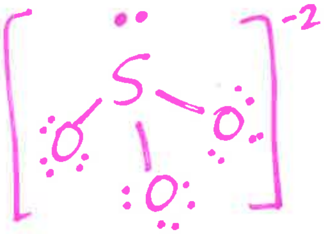
NO_3^{-1}

24



SO_3^{-2}

26



CSe_2

16

SSe_2

18

SI_2

20

CN^{-1}

10

H_2 2

F_2

14

O_2

12

N_2

10

b. The lines in your dot structures represent bonds. Are these ionic or covalent bonds (which one)? Explain your answer in terms of what is going on with the electrons.

Covalent! Each line (covalent bond) consists of 2 shared electrons. (Atoms share e-)