CHEM A EXAM REVIEW!! Name: Key 2014

1. Titanium has a density of 4.5 g/cm^3. Find the volume of 12.3 grams of titanium.

$D = \frac{m}{V}$ $V = \frac{m}{D}$ $V = \frac{12.3\,g}{4.5\,g/cm^3} = 2.733 \rightarrow$ **2.7 cm^3 or mL**

2. A metal's density is determined using water displacement.
Use the following data to calculate the density of the metal.

Mass of empty beaker: 62.33 g
Mass of beaker and chunk of metal: 78.73 grams → 16.40 g metal
Initial water level in a graduated cylinder: 43.8 mL
Volume of water and metal together: 45. 9 mL → 2.1 mL displacement

$D = \frac{m}{V} = \frac{16.40\,g}{2.1\,mL} =$ **7.8 g/mL**

3. Make the following conversions:

a. 75 milligrams to grams

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

b. 8.0 feet per minute to millimeters per hour

$\frac{8.0\,ft}{min}\left(\frac{12\,in}{1\,ft}\right)\left(\frac{2.54\,cm}{1\,in}\right)\left(\frac{10\,mm}{1\,cm}\right)\left(\frac{60\,min}{1\,hr}\right) = 146304 \sim$ **1.5×10^5 mm/hr**

c. 100. cubic inches to cubic centimeters.

$100.\,in^3\left(\frac{2.54\,cm}{1\,in}\right)^3 = 1638.7 \sim$ **1640 cm^3**

4. 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. 0.0022 x 198 = 0.4356 -----> 0.44

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

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

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

p+N

5.

Symbol	#protons	# neutrons	#electrons	mass#	charge	atomic # (p)
$^{75}As^{+5}$	33	42	28	75	+5	33
66 Zn^{+2}	30	36	28	66	+2	30
131 I^{-1}	53	78	54	131	-1	53

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

30.97 ≈ 31 31 − 15 = 16

7. 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).

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

100 − 62.7 = 37.3% Ir-191

$(0.627)(192.963\ \text{amu}) + (0.373)(190.9606\ \text{amu}) = 192.216 \approx 192.22\ \text{amu}$

p + n

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

8. Give the symbol for four ions that have the same number of electrons (10 e⁻) as Neon. N^{-3} O^{-2} F^{-1} Na^{+1} Mg^{+2} Al^{+3}

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

(I) copper (II) sulfate $CuSO_4$	Iron (III) phosphate (I) $FePO_4$	zinc phosphate I $Zn_3(PO_4)_2$	chlorine (C) Cl_2
N_2O_4 (C) dinitrogen tetroxide	PF_5 (C) phosphorus pentafluoride	B_2O_3 (C) diboron trioxide	Al_2O_3 (I) aluminum oxide
Na_3PO_4 I sodium phosphate	(C) Cl_2O_7 dichlorine heptoxide	$PbCO_3$ (I) Lead (II) carbonate	Sn_3N_4 (I) Tin (IV) nitride
ammonium carbonate (I) $(NH_4)_2CO_3$	Iron (II) carbonate (I) $FeCO_3$	Ag_2SO_3 (I) Silver Sulfite	SO_3 (C) sulfur trioxide
ferric hydroxide (I) $Fe(OH)_3$	CO_2 (C) carbon dioxide	$SiBr_4$ (C) silicon tetrabromide	Zinc acetate (I) $Zn(CH_3COO)_2$
NO (C) nitrogen monoxide	N_2O (C) dinitrogen monoxide	Helium He	nitrogen (C) N_2
CuO (I) Copper (II) oxide +2	Cu_2S (I) copper (I) sulfide		

10. a. Write the formula for iron (III) iodide. FeI_3

b. Write a balanced chemical equation for the reaction that would occur if iodine and iron reacted to form iron (III) iodide. Include phase subcripts.

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

c. Which element is oxidized (loses electrons) in this reaction? Fe

d. Which element is reduced (gains electrons) in this reaction I

f. What type of compound (ionic or covalent) is formed in this reaction? Explain how you know.

Ionic - metal ion + nonmetal ion

11. a. Which substances form ions with an "ide" ending: metals or nonmetals?

Nonmetals

b. What is the difference between an ion that ends in "ide," "ite," and "ate"?

-ide = single atom made into anion ex) Cl^{-1}, S^{-2}, N^{-3}

-ate = neg ion with oxygen ex) NO_3^{-1}, SO_4^{-2}, PO_4^{-3}

-ite = like -ate but with one less oxygen ex) NO_2^{-1}, SO_3^{-2}

12. Moles! Make the following conversions.

a. 3.08×10^{22} iron atoms to moles

$$3.08 \times 10^{22}\ \text{Fe atoms}\left(\frac{1\ \text{mol}}{6.02\times10^{23}\ \text{atoms}}\right) = 0.0512\ \text{mol Fe}$$

b. 3.32 grams of hydrogen gas (H_2) to moles

$$3.32\ \text{g}\ H_2\left(\frac{1\ \text{mol}}{2.02\ \text{g}}\right) = 1.65\ \text{mol}\ H_2$$

c. 10.0 moles of carbon dioxide to grams

$$10.0\ \text{mol}\ CO_2\left(\frac{44.01\ \text{g}}{1\ \text{mol}}\right) = 440.\ \text{g}\ CO_2$$

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

$$3.2\times10^{20}\ \text{molec}\left(\frac{1\ \text{mol}}{6.02\times10^{23}\ \text{molec}}\right)\left(\frac{44.01\ \text{g}}{1\ \text{mol}\ CO_2}\right) = 0.023\ \text{g}\ CO_2$$

13. a. Determine the percent composition of nitrogen in $(NH_4)_2S$. $2N + 8H + S = 68.14$ amu total

$$\%N = \frac{2(14.01)}{68.14} = 41.11\%\ N$$

$$\%H = \frac{8(1.01)}{68.14} = 11.8\%\ H$$

$$\%S = \frac{32.07}{68.14}\times100 = 47.06\%\ S$$

b. How many grams of nitrogen are in 20.0 total grams of ammonium sulfide [$(NH_4)_2S$]?

$$\frac{41.11}{100} = \frac{x}{20.0\ \text{g}}$$

$$x = 8.22\ \text{g}\ N$$

14. a. What is the empirical formula of $C_8H_{12}O_4$? C_2H_3O

b. A compound with a molecular weight 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

$85.7\text{ g C}\left(\frac{1\text{ mol}}{12.011\text{ g}}\right) = \frac{7.14\text{ mol C}}{7.14} = 1$

$14.3\text{ g H}\left(\frac{1\text{ mol}}{1.01\text{ g}}\right) = \frac{14.19\text{ mol H}}{7.14} = 2$

C_1H_2 = empirical formula

$C_1H_2 = 14.03$ g/mol or amu

$\frac{80\text{ amu}}{14.03\text{ amu}} = 5.7 \approx 6$

C_6H_{12} = MF

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

FLIP!

$26.6\text{ g K}\left(\frac{1\text{ mol K}}{39.10\text{ g}}\right) = \frac{0.680\text{ mol K}}{0.680} = 1$ (x2)

$35.3\text{ g Cr}\left(\frac{1\text{ mol Cr}}{52.00\text{ g}}\right) = \frac{0.680\text{ mol Cr}}{0.680} = 1$ (x2)

$38.1\text{ g O}\left(\frac{1\text{ mol O}}{16.00\text{ g}}\right) = \frac{2.38\text{ mol O}}{0.680} = 3.5$ (x2)

$K_2Cr_2O_7$

potassium dichromate

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:

$27.021 - 26.000 =$ 1.021 g Cu

the mass of copper oxide that formed:

$27.272 - 26.000 =$ 1.272 g Cu_xO_y

the mass of oxygen that bonded with copper:

$1.272 - 1.021 =$ 0.251 g oxygen

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

$\frac{0.251\text{ g O}}{1.272\text{ g } Cu_xO_y} * 100 =$ 19.7% O

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

Cu_2O

$\%O = \frac{16.00}{143.10} \times 100 = 11.18\%$ O

CuO

$\%O = \frac{16.00}{79.55} \times 100 = 20.11\%$ O

closer!

16. An experiment was done to determine molarity of a hydrochloric acid solution. 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.

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

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

58.33 − 56.77 = 1.56 g Zn reacted

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

$1.56\text{ g Zn}\left(\frac{1\text{ mol Zn}}{65.38\text{ g}}\right)\left(\frac{2\text{ mol HCl}}{1\text{ mol Zn}}\right) = 0.0477\text{ mol HCl}$

d. Recall that the formula for a solution's molarity is equal to the moles solute per liter solution. Calculate the molarity of the HCl solution.

$M = \frac{0.0477\text{ mol HCl}}{0.0600\text{ L}} = \boxed{0.795\text{ M HCl}}$

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

18. 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) ------> $Fe_2(SO_4)_3 + 6\,AgCl_{(s)}$

c. 2 Al (s) + 3 $Ni(NO_3)_2$(aq) ------> $2\,Al(NO_3)_3 + 3\,Ni_{(s)}$

d. 2 C_4H_{10} (l) + 13 O_2 (g) ------> $8\,CO_2 + 10\,H_2O$

e. 6 HNO_3(aq) + 2 Al (s) ------> $2\,Al(NO_3)_3 + 3\,H_2$

f. 4 K(s) + O2 (g) ------> $2K_2O_{(s)}$

g. 3 F_2 (g) + 2 $FeCl_3$(aq) ------> $2\,FeF_3 + 3\,Cl_2$

h. I_2 (s) + NaCl (aq)------> NR (halogen activity)

i. $Al(NO_3)_3$ (aq) + 3 NaCl (aq) ------> $AlCl_{3(aq)} + 3\,NaNO_{3(aq)}$ ← technically NR since no solid

j. $HCl(aq) + LiOH(aq) \longrightarrow$ $H_2O + NaCl$

k. $FeCl_3(aq) + 3\,AgNO_3(aq) \longrightarrow$ $Fe(NO_3)_3 + 3\,AgCl_{(s)}$

h. $Pb(NO_3)_4(aq) + 2\,Zn(s) \longrightarrow$ $2\,Zn(NO_3)_2 + Pb_{(s)}$

19. $3\,Zn_{(s)} + 7\,H_2SO_{4(aq)} + K_2Cr_2O_{7(aq)} \longrightarrow Cr_2(SO_4)_{3(aq)} + 7\,H_2O_{(l)} + 3\,ZnSO_{4(aq)} + K_2SO_{4(aq)}$

a. If 10.0 grams of sulfuric acid react, what mass of zinc sulfate will be produced? (assume excess other reactants)

$$10.0\text{g } H_2SO_4\left(\frac{1\text{ mol } H_2SO_4}{98.08\text{g}}\right)\left(\frac{3\text{ mol } ZnSO_4}{7\text{ mol } H_2SO_4}\right)\left(\frac{161.44\text{g}}{1\text{ mol } ZnSO_4}\right) = 7.05\text{ g } ZnSO_4$$

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

$$\frac{\text{lab}}{\text{theo}} \times 100 = \frac{6.55\text{g}}{7.05\text{g}} \times 100 = 92.8\%\text{ Yield}$$

20. $2\,Fe_{(s)} + 6\,HCl_{(aq)} \longrightarrow 2\,FeCl_{3(aq)} + 3\,H_{2(g)}$

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? This is a limiting reactant problem!

$$50.0\text{g Fe}\left(\frac{1\text{ mol Fe}}{55.85\text{g}}\right)\left(\frac{2\text{ mol } FeCl_3}{2\text{ mol Fe}}\right)\left(\frac{162.21\text{g}}{1\text{ mol } FeCl_3}\right) = 145\text{g } FeCl_3$$

$$\underset{LR}{85.0\text{g HCl}}\left(\frac{1\text{ mol HCl}}{36.46\text{g}}\right)\left(\frac{2\text{ mol } FeCl_3}{6\text{ mol HCl}}\right)\left(\frac{162.21\text{g}}{1\text{ mol } FeCl_3}\right) = 126\text{g } FeCl_3$$

21. For each atom or ion:

a. Write the electron configuration. S+P in outer main shell

b. Underline the valence electrons, and indicate the number of valence electrons it has.

#95 Am $[Rn]\,\underline{7s^2\,5f^7}$ 2ve

#55 Cs $[Xe]\,\underline{6s^1}$ 1 ve

#32 Ge $[Ar]\,\underline{4s^2\,3d^{10}\,4p^2}$ 4 ve

#41 Nb $[Kr]\,\underline{5s^2\,4d^3}$ 2 ve

#85 At $[Xe]\,\underline{6s^2}\,4f^{14}\,5d^{10}\,\underline{6p^5}$ (7 ve)

C $1s^2\,\underline{2s^2\,2p^2}$ (4 ve)

magnesium ion $-10e^-$

Mg^{+2}: $1s^2\,\underline{2s^2\,2p^6}$ $-$ (8 ve$^-$)

bromide ion

Br^{-1} $[Ar]\,\underline{4s^2\,3d^{10}\,4p^6}$ (8 ve)

22. 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

e⁻ further away from nucleus = higher energy

b. EM radiation with a frequency of 1.21×10^{14} Hz. or with a frequency of 8.21×10^{13} Hz.

higher frequency = higher energy

c. An electron in a 5s orbital or An electron in a 5f orbital

5f is further from the nucleus than 5s

d. EM radiation with a wavelength of 1774 nm, or with a wavelength of 344 nm.

Shorter λ = higher energy

e. yellow light or green light

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

e⁻ further from nucleus = higher energy

23a. Determine the frequency, in Hertz, of EM radiation with a photon energy of 6.99×10^{-26} J.

$E = h \cdot \nu$

$\frac{E}{h} = \nu$ $\quad \frac{6.99 \times 10^{-26}\ \text{J}}{6.63 \times 10^{-34}\ \text{J} \cdot \text{s}} = 1.05 \times 10^{8}\ \frac{1}{\text{sec}}\ (\text{Hz})$

b. Determine the energy, in Joules, of EM radiation with a wavelength of 4.1 nm.

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

$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34}\ \text{J} \cdot \text{s})(3.00 \times 10^{8}\ \text{m/s})}{(4.1 \times 10^{-9}\ \text{m})} = 4.85 \times 10^{-17}\ \text{J}$