University of Louisville **Chem 201 Exam 1 Dr. Hoyt** **Fall 2017**

name Key

Scored grade (instructor use only!)_____

1. Write **balanced** chemical equations, with appropriate phase labels, for the following reactions. In both cases, you may use as much scratch space as you need, but write your final answer **legibly** in the box.

a. [10 pts] **Copper(II) oxide reacts with methane to produce carbon monoxide, water, and copper.** (Cu^{2+} O^{2-})

$$3\,CuO_{(s)} + CH_{4(g)} \rightarrow CO_{(g)} + 2H_2O_{(g)\text{ or }(l)} + 3Cu_{(s)}$$

(remember to balance rxn and include phase labels)

b. [10] **Ethanol (C_2H_6O) combusts.

$$C_2H_6O_{(l)\text{ or }(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)\text{ or }(l)}$$

(remember to balance rxn and include phase labels)

2. (a) [2] Beryllium has two naturally occurring isotopes, ^{9}Be and ^{10}Be. An atom of ^{9}Be has mass = 9.012182 μ. What can you conclude about the abundance of ^{10}Be, based on the average mass given in the periodic table? (Hint: what's the approximate percent abundance of ^{9}Be?) *Briefly* support any assertions you make.

Since the average atomic mass matches the mass of ^{9}Be to 4 sig. figs., ^{9}Be must be 100.0% of naturally occurring Be. ^{10}Be must be <0.1%. (More specific calculations or analyses could also be made.)

(b) [3] How many protons, neutrons and electrons are in a single $^{10}Be^{2+}$ ion?

protons 4 neutrons 6 electrons 2

name Key

3. [2 pts] A student preparing for an experiment weighs an empty beaker and records its mass as 63.347 g. She then adds a sample of copper(II) oxide, weighs the beaker containing the sample, and records the mass as 64.037 g. What is the mass of the sample, in grams? (Record your answer, rounded to the appropriate precision, in the space.)

$$\begin{array}{r} 64.037 \\ -\ 63.347 \\ \hline 0.690 \end{array}$$

Answer: 0.690 g (3 decimal places required)

4. (a) [1 pt] A covalent compound of Si and Cl consists of 20.9% Si by mass. What is the % Cl in the compound?

$$\begin{array}{r} 100.0 \\ -\ 20.9 \\ \hline 79.1 \end{array}$$

Answer: 79.1 % 3 s.f.

(b) [3 pts] What is the **empirical formula** of the compound? **Show your work below** to earn credit, and write the formula in the space.

In 100 g:

$$20.9\ g\ Si \times \frac{mol}{28.09\ g} = 0.744\ mol$$

Answer: $SiCl_3$

$$79.1\ g\ Cl \times \frac{mol}{35.45\ g} = 2.23\ mol$$

$$\frac{2.23\ mol\ Cl}{0.744\ mol\ Si} = 3.00\ mol\ Cl / mol\ Si$$

(c) [2] Write two other possible chemical formulas that are consistent with the empirical formula you wrote above.

Si_2Cl_6 Si_3Cl_9

(d) [2] A different experiment indicates that the compound described in (a) has a molar mass of approximately 270 g/mol. What is the chemical formula of the compound?

$SiCl_3$: $28.09 + 3(35.45) = 134.44$ Si_2Cl_6

$$\frac{270}{134} = 2 \quad \text{or} \quad 2 \times SiCl_3$$

name Key

5. (a) [3] What is the molar mass of $Hg(MnO_4)_2$? **Show your work** below, and report your answer, with appropriate rounding and unit(s), in the space provided.

Answer: 438.5 g/mol

Hg = 200.6
Mn x 2 = 54.94 x 2 = 109.88
O x 8 = 16.00 x 8 = 128.00
438.48 → round to 1 decimal place: 438.5 g/mol

(b) [6] Consider a 5.00-mol sample of $Hg(MnO_4)_2$.

What is the mass of the sample? 2190 g or 2.19 kg $5.00\,mol \times \frac{438.5\,g}{mol} = 2192.5\,g$

How many **moles of O** are present? 40.0 mol O $5.00\,mol\ Hg(MnO_4)_2 \times \frac{8\,mol\,O}{mol\,Hg\,...} = 40.0\,mol\,O$

How many **atoms of Mn** are present? 6.02×10^{24} atoms $5.00\,mol \times \frac{2\,mol\,Mn}{mol} \times \frac{6.02 \times 10^{23}\,atoms}{mol} =$

6. [2 pts each] **Clearly** indicate whether each statement is TRUE or FALSE. If we can't tell which you mean, it's wrong.

true H_2 is diatomic, but not binary.

true H can form both H^+ and H^- ions.

true Hydrogen is a gas at room temperature.

false Hydrogen is a metal.

false In the most common isotope of hydrogen, the atoms have one electron, one proton and one neutron.

false The number of electrons and protons in an atom or ion must always be equal.

7. [2 pts each] Fill in the blanks. (In some cases there could be more than one acceptable answer; pick **one**.)

Mg An element that always forms +2 ions in compounds. any Group 2 + Zn

He A substance that exists as individual gas-phase atoms under normal laboratory conditions. any Group 18

C An element that forms covalent compounds but doesn't form monatomic ions. B, C, Si

I A nonmetal in period 5. Sb, Te, I, Xe

(1) (1)

name Key

8. [2 pts each] Give a **correct systematic name** for each of the following. Spelling counts.

zinc chlorate	$Zn(ClO_3)_2$
sulfur trioxide	SO_3
iodine pentafluoride	IF_5
iron(II) oxide	FeO
ammonia	NH_3

9. [2 pts each] Give the correct **chemical formula** for each of the following.

K	elemental potassium	$Ca_3(PO_4)_2$	calcium phosphate
$H_2AsO_4^-$	dihydrogen arsenate ion	$SiCl_4$	silicon tetrachloride
H_2SO_3	sulfurous acid	Br_2	elemental bromine
$Ag_2S_2O_3$	silver thiosulfate	NaIO	sodium hypoiodite

10. $2\ Mg + O_2 \rightarrow 2\ MgO$ $\begin{array}{r} 24.31 \\ +16.00 \\ \hline 40.31\ g \end{array}$

A student carries out the reaction above, starting with 48 g of Mg and 48 g of O_2 in a sealed container.

(a) [6 pts] What mass of product is formed from the complete reaction? (Show work, include unit(s), round appropriately)

Answer: 80. g MgO

$$48\ g\ Mg \times \frac{mol\ Mg}{24.31\ g\ Mg} \times \frac{2\ mol\ MgO}{2\ mol\ Mg} \times \frac{40.31\ g\ MgO}{mol\ MgO} = 79.6\ g\ MgO$$

$$48\ g\ O_2 \times \frac{mol\ O_2}{32.00\ g\ O_2} \times \frac{2\ mol\ MgO}{1\ mol\ O_2} \times \frac{40.31\ g\ MgO}{mol\ MgO} = 120.93\ g\ MgO$$

(b) [4 pts] Which reactant is left over, and what mass of that reactant remains after the reaction is complete? (Show work, include unit(s), round appropriately)

Answer: 16 g O_2 left over

O_2 is left.

$$48\ g\ Mg \times \frac{mol\ Mg}{24.31\ g\ Mg} \times \frac{mol\ O_2}{2\ mol\ Mg} \times \frac{32.00\ g\ O_2}{mol\ O_2} = 31.6\ g\ O_2\ \text{used}$$

$$48\ g - 31.6\ g = 16\ g\ O_2\ \text{left}$$