name_____

University of Louisville **Chem 201 Exam 2 Dr. Hoyt** **Fall 2017**

Scored grade (instructor use only!)_____

1 Write **balanced net ionic** equations, with appropriate phase labels, for the following reactions. In each case, you may use as much scratch space as you need, but write your final answer **legibly** in the box. *(If you may want your scratch work considered for partial credit, make sure it's preserved somewhere on the exam pages you turn in.)*

$HC_2H_3O_2$ Na^+ HCO_3^-

a. [10 pts] **Acetic acid reacts with sodium hydrogen carbonate.**

total: $HC_2H_3O_2(aq) + NaHCO_3(aq) \rightarrow H_2O(l) + CO_2(g) + NaC_2H_3O_2(aq)$

ionic: $HC_2H_3O_2(aq) + Na^+(aq) + HCO_3^-(aq) \rightarrow H_2O(l) + CO_2(g) + Na^+(aq) + C_2H_3O_2^-(aq)$

net ionic: $HC_2H_3O_2(aq) + HCO_3^-(aq) \rightarrow H_2O(l) + CO_2(g) + C_2H_3O_2^-(aq)$

(remember to balance reaction, write as net, and include phase labels)

b. [10] **Aqueous barium chloride reacts with sulfuric acid.**

total: $BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$

ionic: $Ba^{2+}(aq) + 2Cl^-(aq) + 2H^+(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + 2H^+(aq) + 2Cl^-(aq)$

net ionic: $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

(remember to balance reaction, write as net, and include phase labels)

c. [6] **Pure magnesium chlorate dissociates in water.**

$Mg(ClO_3)_2(s) \rightarrow Mg^{2+}(aq) + 2ClO_3^-(aq)$

(remember to balance reaction, write as net, and include phase labels)

2 [2 each] Identify each of the following as:

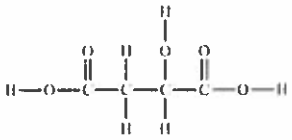
A a strong acid B a weak acid C neutral D a weak base E a strong base

D ammonia

C sodium chloride

D potassium acetate

A perchloric acid

B 

E K_2O

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3 [1 each] Assign oxidation numbers for each of the identified elements.

H in H_2 0 H in CH_4 +1 H in NaH −1

O in H_2O_2 −1 Cr in $Fe_2(CrO_3)_3$ +4

+3 H4 −2

+6 +12 −18 = 0

4 [2 pts each] **Clearly** indicate whether each statement is TRUE or FALSE. If we can't tell which you mean, it's wrong.

false H_2 is an acid.

true Carbon dioxide dissolves in water to form an acidic solution.

false Ionic compounds are always soluble in water at room temperature.

false In a reaction, the reactant present in the smaller molar amount is the limiting reactant.

true All precipitates are insoluble compounds and all insoluble compounds are precipitable.

true Ionic compounds are soluble in water when hydration is strong enough to overcome the ionic bonds.

false In water, the oxygen atoms carry a charge of –2.

false HCl is an ionic compound, which dissociates completely in aqueous solution.

false Substances that dissolve in water also dissociate, so the terms "dissolve" and "dissociate" are interchangeable in aqueous chemistry;

5 [2 pts each] Fill in the blanks. (In some cases there could be more than one acceptable answer; pick **one**. Any chemical species you choose must be consistent with normal laboratory conditions on earth.)

H_2SO_4 A diprotic acid. H_2SeO_4, H_2CO_3, H_2CrO_4, etc... (also $H_2PO_4^-$ and similar)

NaOH A strong base. any soluble compound of a metal with OH^- or O^{2-}

H_2 A chemical substance containing an atom with oxidation number = 0. any element in its stable state. Also, $C_{12}H_{22}O_{11}$ and similar.

NO_3^- A nonbasic anion. any anion of a strong acid (Cl^-, NO_3^-, ClO_4^-, SO_4^{2-}, Br^-, I^-)

$NaReO_4$ A soluble compound of the perrhenate ion, ReO_4^-. Compound with any Group I ion, NH_4^+, or H^+

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$S_4 = 4 \times 32.07 = 128.28$
$N_4 = 4 \times 14.01 = 56.04$
184.32 g/mol

6 $S_4N_4 + 4\ Ag_2O \rightarrow 4\ Ag_2S + 4\ NO$

The reaction is conducted beginning with 50.63 g S_4N_4 and 137.22 g Ag_2O.

(a) [2] How many moles of S_4N_4 are present at the start of the reaction? (Show work, include unit(s), round appropriately)

$50.63\text{ g} \times \frac{\text{mol}}{184.32\text{ g}} = 0.27469\text{ mol}$ (4 s.f.)

Answer: 0.2747 mol (4 sf)

2

N 14.01
O + 16.00
30.01 g/mol

(b) [6 pts] What mass of NO is formed from the complete reaction? (Show work, include unit(s), round appropriately)

Answer: 17.77 g NO (4sf)

if S_4N_4 is limiting: $0.27469\text{ mol } S_4N_4 \times \frac{4\text{ mol NO}}{1\text{ mol } S_4N_4} \times \frac{30.01\text{ g NO}}{\text{mol NO}} = 32.97\text{ g NO}$

6 if Ag_2O is limiting: $137.22\text{ g } Ag_2O \times \frac{1\text{ mol } Ag_2O}{231.8\text{ g } Ag_2O} \times \frac{4\text{ mol NO}}{4\text{ mol } Ag_2O} \times \frac{30.01\text{ g NO}}{\text{mol NO}} = 17.77\text{ g NO}$

$Ag_2 = 2 \times 107.9 = 215.8$
O 16.00
231.8 g/mol

(c) [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: 23.35 g S_4N_4 (4 sf)

4 S_4N_4 is left.

$137.22\text{ g } Ag_2O \times \frac{1\text{ mol } Ag_2O}{231.8\text{ g } Ag_2O} \times \frac{1\text{ mol } S_4N_4}{4\text{ mol } Ag_2O} \times \frac{184.32\text{ g } S_4N_4}{\text{mol } S_4N_4} = 27.28\text{ g } S_4N_4 \text{ used in rxn.}$

50.63 g at start
23.35 g S_4N_4 remains

(d) [2] If the experimenter captures 17.04 g of NO at the end of the experiment, what is the percent yield? (Show work, include unit(s), round appropriately)

Answer: 95.89%

2

$\frac{17.04\text{ recovered}}{17.77\text{ calcd.}} \times 100 = 95.89\%$

(e) [1 each] Provide appropriate **phase labels** for each of these substances. (Assume pure substances under normal laboratory conditions.)

3 Ag_2O (s) Ag_2S (s) NO (g)

(f) [2 each] Provide a correct systematic name for each of these substances.

4/24 S_4N_4 tetrasulfur tetranitride Ag_2S silver sulfide

name _____

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7 [5] Circle the formulas that represent **insoluble** ionic compounds.

K_3PO_4 $Al(OH)_3$ CaC_2O_4 $Co(CH_3CO_2)$ H_2CrO_4

8 [3] In the space provided, sketch the molecular-level interaction between a calcium ion and a water molecule. Represent relevant charges accurately.