Station 1: Ionization Reactions

*Directions: For each of the following **acids**, write the ionization reaction that displays what happens to the acid in water. Ionization should include only 1 of the hydrogen atoms. Remember that the charges on both sides of the equation must balance.*

Example: H_2SO_3: $H_2SO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HSO_3^-(aq)$

1. H_3PO_4: _____
2. H_2SO_4 : _____
3. HF: _____
4. HBr: _____

Directions: For each of the following bases, write the ionization reaction that displays what happens to the base in water. Assume that all bases start as solids. Remember that the charges and atoms on both sides of the equation must balance.

Example: NaOH: $NaOH\ (s) \rightarrow Na^+\ (aq) + OH^-\ (aq)$

5. LiOH: _____
6. $Ca(OH)_2$: _____
7. $Ba(OH)_2$: _____
8. $Fe(OH)_3$: _____

Station 2: Identifying Arrhenius Acids and Bases

1. Complete the following neutralization equations. Make sure each equation is balanced, and circle the salt produced.

   a. $CH_3COOH + LiOH \rightarrow$

   b. $Mg(OH)_2 + H_3PO_4 \rightarrow$

   c. Sulphuric acid reacting with iron(III) hydroxide

2. Write the formula and the name for the parent acid and the parent base that react to form each salt listed:

	Parent Acid	Parent Base
a. KNO_2		
b. NH_4Cl		
c. CuC_2O_4		

Station 3: Identifying Conjugate Acid-Base Pairs

1. In the following equilibrium, identify the acids and bases, and the two conjugate acid-base pairs:

$$HF_{(aq)} + CN^-_{(aq)} \rightleftharpoons HCN_{(aq)} + F^-_{(aq)}$$

2. Complete the following table:

Conjugate Acid	Conjugate Base
$H_2C_2O_4$	
	SO_3^{2-}
HCO_3^-	
	H_2O

3. Complete the following equilibrium, which represents the reaction of a Bronsted-Lowry acid and base. Circle the substances that make up one of the conjugate acid base pairs.

$$NO_2^-{}_{(aq)} + H_2CO_{3(aq)} \rightleftharpoons$$

4. Write the Bronsted-Lowry acid-base equilibria which occurs when the following pairs of substances are mixed in solution.

   a. HPO_4^{2-} and SO_4^{2-}

   b. HIO_3 and $C_2O_4^{2-}$

Station 4: Amphiprotic Species

1. Write an equation for a reaction between HCO_3^- and CN^- where HCO_3^- acts as an acid.

2. Write an equation for a reaction between HCO_3^- and H_2O where HCO_3^- acts as a base.

3.
    a. Identify the amphiprotic substances in the following list:
        i. CH_3COOH
        ii. $H_2PO_4^-$
        iii. PO_4^{3-}
        iv. $H_2C_2O_4$
        v. $HC_2O_4^-$

    b. Explain what an amphiprotic species is and give the characteristics it must possess.

ANSWER KEY

Station 1	
1.	$H_3PO_{4(aq)} + H_2O \rightarrow H_3O^+ + H_2PO_4^-$
2.	$H_2SO_{4(aq)} + H_2O \rightarrow H_3O^+ + HSO_4^-$
3.	$HF_{(aq)} + H_2O \rightarrow H_3O^+ + F^-$
4.	$HBr_{aq)} + H_2O \rightarrow H_3O^+ + Br^-$
5.	$LiOH(s) \rightarrow Li^+_{(aq)} + OH^-_{(aq)}$
6.	$Ca(OH)_2(s) \rightarrow Ca^{2+}_{(aq)} + 2\ OH^-_{(aq)}$
7.	$Ba(OH)_2(s) \rightarrow Ba^{2+}_{(aq)} + 2\ OH^-_{(aq)}$
8.	$Fe(OH)_3(s) \rightarrow Fe^{3+}_{(aq)} + 3\ OH^-_{(aq)}$
Station 2	
1.	a. $CH_3COOH_{(aq)} + LiOH_{(aq)} \rightarrow H_2O_{(l)} + LiCH_3COO_{(aq)}$
	b. $3\ Mg(OH)_{2\ (aq)} + 2\ H_3PO_{4(aq)} \rightarrow 6\ H_2O_{(l)} + Mg_3(PO4)_{2(aq)}$
	c. $3\ H_2SO_{4(aq)} + 2\ Fe(OH)_{3(aq)} \rightarrow 6\ H_2O_{(l)} + Fe_2(SO_4)_{3(aq)}$
2.	KNO_2 Parent Acid: HNO_2 – nitrous acid Parent Base: KOH – potassium hydroxide
	NH_4Cl Parent Acid: HCl – hydrochloric acid Parent Base: NH_3 – ammonia or NH_4OH – ammonium hydroxide
	CuC_2O_4 Parent Acid: $H_2C_2O_4$ – oxalic acid Parent Base: $Cu(OH)_2$ – copper(II) hydroxide

Station 3

1. $HF_{(aq)} + CN^-_{(aq)} \rightleftharpoons HCN_{(aq)} + F^-_{(aq)}$
   Acid Base Acid Base

2.

Conjugate Acid	Conjugate Base
$H_2C_2O_4$	**$HC_2O_4^-$**
HSO_3^-	SO_3^{2-}
HCO_3^-	**CO_3^{2-}**
H_3O^+	H_2O

3. $NO_2^-{}_{(aq)} + H_2CO_{3(aq)} \rightleftharpoons$ **$HNO_2 + HCO_3^-$**

4. a. HPO_4^{2-} and SO_4^{2-}

   $HPO_4^{2-} + SO_4^{2-} \rightleftharpoons PO_4^{3-} + HSO_4^-$

   b. HIO_3 and $C_2O_4^{2-}$

   $HIO_3 + C_2O_4^{2-} \rightleftharpoons IO_3^-$ and $HC_2O_4^-$

Station 4

1. **$HCO_3^- + CN^- \rightleftharpoons CO_3^{2-} + HCN$**

2. **$HCO_3^- + H_2O \rightleftharpoons H_2CO_3^{2-} + OH^-$**

3. a. **$H_2PO_4^-$, $HC_2O_4^-$**

   b. Can act both as an acid and as a base.
   An AMPHIPROTIC species has an easily removed hydrogen, and a negative charge

Names: _____

Station 1	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
Station 2	
1.	a.
	b.
	c.
2.	KNO_2 Parent Acid: Parent Base:
	NH_4Cl Parent Acid: Parent Base:
	CuC_2O_4 Parent Acid: Parent Base:

Station 3

1. $HF_{(aq)} + CN^-_{(aq)} \rightleftharpoons HCN_{(aq)} + F^-_{(aq)}$

2.

Conjugate Acid	Conjugate Base
$H_2C_2O_4$	
	SO_3^{2-}
HCO_3^-	
	H_2O

3. $NO_2^-{}_{(aq)} + H_2CO_{3(aq)} \rightleftharpoons$

4. a. HPO_4^{2-} and SO_4^{2-}

   b. HIO_3 and $C_2O_4^{2-}$

Station 4

1.

2.

3. a.

   b.