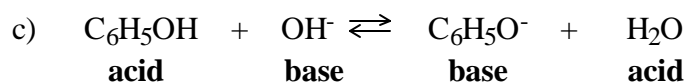
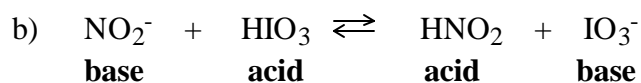
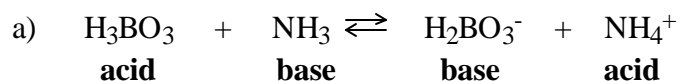


Answer to Question 3 on page 9 of Tutorial 14

3. Identify acids and bases on the left side and the right side of the following equations:

Hint: To get the ones on the right, pretend the reaction is going in reverse.



Answers to Question 4 on pages 10 of Tutorial 14

4. Identify the conjugate acid-base pairs in each of the following reactions:

(NOTE: "Pair 1" and "Pair 2" could be exchanged and the answer would still be correct.)



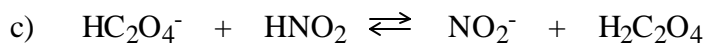
Pair 1: (acid) **CH₃COOH** (base) **CH₃COO⁻**

Pair 2: (acid) **NH₄⁺** (base) **NH₃**



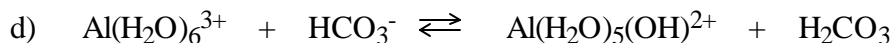
Pair 1: (acid) **H₂SO₃** (base) **HSO₃⁻**

Pair 2: (acid) **H₃PO₄** (base) **H₂PO₄⁻**



Pair 1: (acid) HNO_2 (base) NO_2^-

Pair 2: (acid) $\text{H}_2\text{C}_2\text{O}_4$ (base) HC_2O_4^-



Pair 1: (acid) $\text{Al}(\text{H}_2\text{O})_6^{3+}$ (base) $\text{Al}(\text{H}_2\text{O})_5(\text{OH})^{2+}$

Pair 2: (acid) H_2CO_3 (base) HCO_3^-

Answers to Question 5 on Page 11 of Tutorial 14

5. Find the *conjugate acid* of each of the following. Make sure you have the charges correct:

a) CH_3COO^- conjugate acid is CH_3COOH _____

b) SO_4^{2-} conjugate acid is HSO_4^- _____

c) H_2O conjugate acid is H_3O^+ _____

d) O^{2-} conjugate acid is OH^- _____

e) OH^- conjugate acid is H_2O _____

f) HPO_4^{2-} conjugate acid is H_2PO_4^- (Make sure you have the charge correct.)

g) H_2PO_4^- conjugate acid is H_3PO_4 _____

h) NH_3 conjugate acid is NH_4^+ _____

Answers to Question 6 on page 12 of Tutorial 14.

6. Find the *conjugate base* of each of the following. Make sure you have the charges correct:

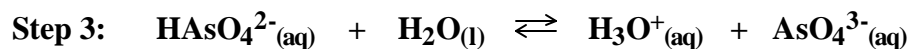
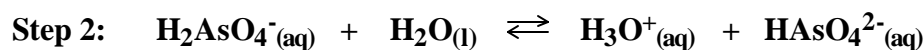
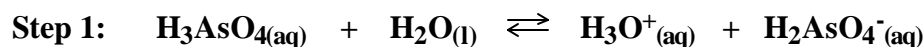
a) HNO_3 conjugate base is NO_3^- _____

b) $\text{H}_2\text{C}_2\text{O}_4$ conjugate base is HC_2O_4^- _____

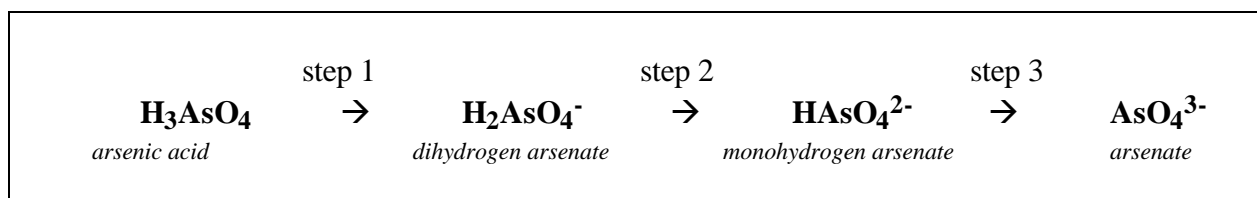
- c) H_2SO_3 conjugate base is HSO_3^-
- d) HNO_2 conjugate base is NO_2^-
- e) HClO_3 conjugate base is ClO_3^-
- f) H_2O conjugate base is OH^-
- g) OH^- conjugate base is O^{2-}
- h) NH_4^+ conjugate base is NH_3

Answer to Question 7 on page 15 of Tutorial 14.

7. a) Write the three equations showing the stepwise dissociation of arsenic acid H_3AsO_4 .

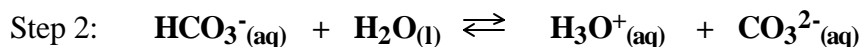
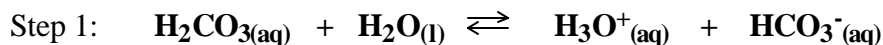


- b) Summarize this process by leaving out the H_3O^+ 's and H_2O 's like was done for phosphoric acid in the example right above this question. See if you can come up with names for all the ions!



Answer to Question 8 on page 17 of Tutorial 14.

8. a) Write the two steps in the dissociation of **carbonic acid** (H_2CO_3).



- b) Give the formula and the name for the amphiprotic anion formed in this process.

Formula HCO_3^-

Name (you may use the acid chart.) hydrogen carbonate or bicarbonate

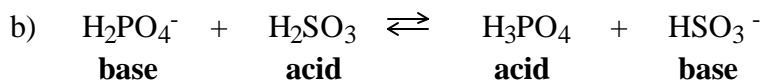
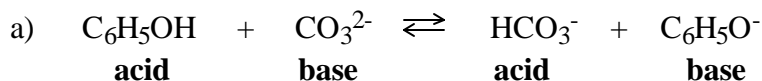
Answers to the Self-Test starting on page 17 of Tutorial 14

- What is meant by a *hydronium ion*? H_3O^+
- How does a hydronium ion form in water? **An H^+ ion attaches itself to a water molecule**
- A hydronium ion can also be called a **hydrated** proton.
- Complete the equations for the *ionization* of the following acids in water:
 - $\text{HClO}_{2(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_3\text{O}^+_{(\text{aq})} + \text{ClO}_2^-_{(\text{aq})}$
 - $\text{HF}_{(\text{g})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_3\text{O}^+_{(\text{aq})} + \text{F}^-_{(\text{aq})}$
 - $\text{HNO}_{2(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_3\text{O}^+_{(\text{aq})} + \text{NO}_2^-_{(\text{aq})}$
 - $\text{HCOOH}_{(\text{l})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_3\text{O}^+_{(\text{aq})} + \text{HCOO}^-_{(\text{aq})}$
- Give the Arrhenius definitions of the following:
 - an acid - **a substance that releases H^+ ions (protons) in water.**
 - a base - **a substance that releases OH^- (hydroxide) ions in water.**

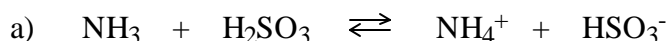
6. Give the ***Bronsted definitions*** of the following:

- a) an acid - **any substance which donates (gives) a proton (H^+) to another substance**
- b) a base - **any substance which accepts (takes) a proton (H^+) from another substance**

7. Identify ***acids*** and ***bases*** on the ***left side*** and the ***right side*** of the following equations:



8. Identify the ***conjugate acid-base pairs*** in each of the following reactions:



Pair 1: (acid) H_2SO_3 (base) HSO_3^-

Pair 2: (acid) NH_4^+ (base) NH_3

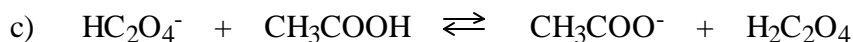
NOTE: It would still be correct if you had pair 1 and pair 2 exchanged.



Pair 1: (acid) $\text{H}_2\text{C}_2\text{O}_4$ (base) HC_2O_4^-

Pair 2: (acid) H_3PO_4 (base) H_2PO_4^-

NOTE: It would still be correct if you had pair 1 and pair 2 exchanged.

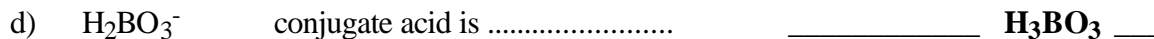
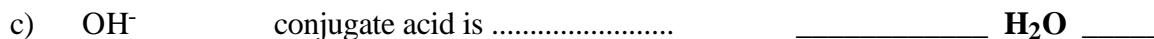
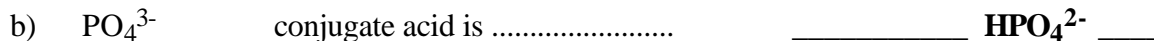
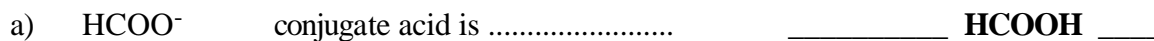


Pair 1: (acid) CH_3COOH (base) CH_3COO^-

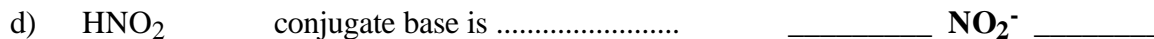
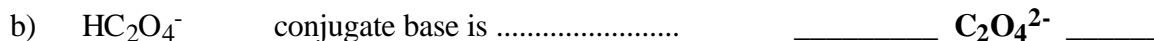
Pair 2: (acid) $\text{H}_2\text{C}_2\text{O}_4$ (base) HC_2O_4^-

NOTE: It would still be correct if you had pair 1 and pair 2 exchanged.

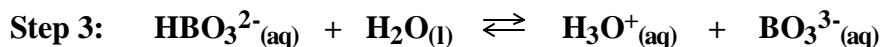
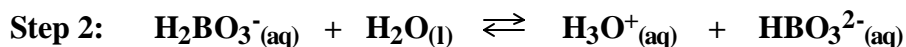
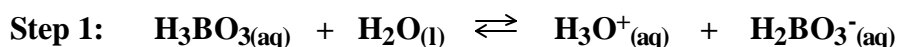
9. Find the *conjugate acid* of each of the following. Make sure you have the charges correct:



10. Find the *conjugate base* of each of the following. Make sure you have the charges correct:



11. a) Write the three equations showing the stepwise dissociation of *boric acid* (H_3BO_3).



b) Give the formulas and the names for the *amphiprotic anions* formed in this process.

Formula H_2BO_3^- Name **dihydrogen borate**

Formula HBO_3^{2-} Name **monohydrogen borate**

12. If the ion HPO_3^{2-} was to act an *acid*, it would form PO_3^{3-}
13. If the ion HPO_3^{2-} was to act a *base*, it would form H_2PO_3^-
14. How can you recognize an *amphiprotic anion*? It has at least one "H" and it has a negative charge

This is the end of Tutorial 14 - Solutions
