

Conjugate Acids and Bases

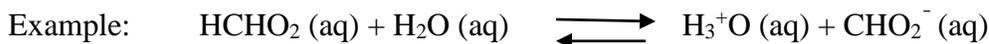
- A. The heart of the Bronsted-Lowry concept of acids and bases is that acid-base reactions are proton transfer reactions.

An **acid** is a proton *donor*.

A **base** is a proton *acceptor*.

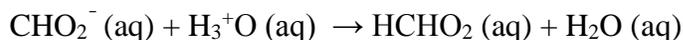


∴ HCl is an acid, it donates a H^+ and H_2O is a base, it accepts the H^+ .

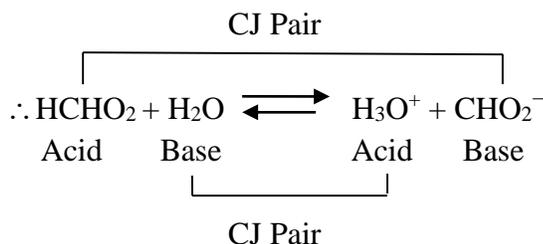


The formic acid molecule is donating a proton to a water molecule and behaves as an acid. Water accepts the proton and behaves as a base (proton acceptor).

- B. The reverse reaction:



H_3O^+ behaves as an acid, as it donates a proton to the CHO_2^- ion. The CHO_2^- ion behaves as a base accepting the proton. Accordingly, there are two acids and two bases in this reaction. Substances that differ from each other by a proton are referred to as a conjugate acid base pair (CJ Pair).

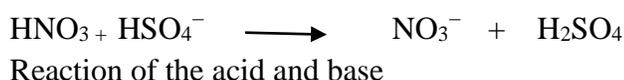
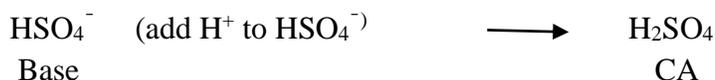
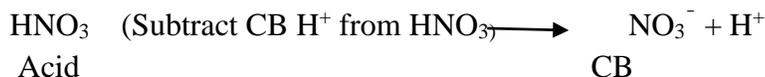


- C. One method of solving these problems involves identifying the acid in the left side of the equation as the other component will be the base on the left side of the equation. On the right side of this equation look for the material that has a difference of a proton from the left side. Therefore H_3O^+ is a CJ acid of H_2O and CHO_2^- is conjugate base of HCHO_2 , since it cannot provide another hydrogen for H_2O .
- D. Determining the conjugate acid or conjugate base of existing compound.

Question 1: Find the conjugate base of HNO_3 and conjugate acid of HSO_4^- .

- The first step is to recognize that members of any conjugate acid-base pair differ by one H^+ . The member having the greater number of hydrogen ions is the acid.

2. The second step is to recognize that the conjugate base (CB) of an acid will have one **less hydrogen ion** and that the conjugate acid (CA) of a pair will have one **more hydrogen ion**. Another option for expressing this statement is to note that the H^+ ion is positive and will involve addition while the OH^- ion is negative and will involve a subtraction of a proton. H^+ represents acid and OH^- represents base.



3. Charges on these substances also change so that solutions remain electrically neutral.

Question 2: Identify the two acids and the two bases in this reaction.



1. Acids have more H^+ than bases:



E. Determine if a substance is amphoteric

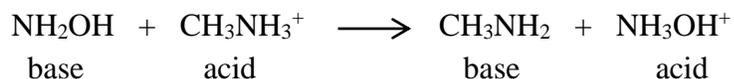
- When a negative charge is associated with a compound and a hydrogen atom is available within the compound, it will always be amphoteric.
- If a compound has no H present within the structure, it will not be amphoteric. There is no proton (i.e. hydrogen) to donate.
- Otherwise, a Lewis structure must be drawn to determine if the central atom of a compound can accept a hydrogen atom. Are there unpaired electrons that can accept a hydrogen atom?
 - If there are no unpaired electrons, then no hydrogen can be added and the material is not amphoteric.
 - If there are unpaired electrons, draw a Lewis structure and determine if the structure is stable and satisfies valence electron criteria.
- Strong acids cannot accept H^+ .

Quiz: Is it amphoteric or not??

- | | |
|------------------------------|--|
| 1. H_2PO_4^- | Amphoteric |
| 2. HPO_4^- | Amphoteric, can accept and donate, check Lewis structure |
| 3. H_2S | Amphoteric (same structure as water) |
| 4. H_3PO_4 | Not amphoteric, strong acid, can only donate |
| 5. NH_4^+ | Not amphoteric, can only donate, check Lewis structure |
| 6. H_2O | Amphoteric, check Lewis structure |
| 7. HI | Not amphoteric, can only donate, check Lewis structure |
| 8. HNO_3 | Not amphoteric, strong acid, can only donate |

- F. The position of an acid-base equilibrium favors weaker acids and bases. Therefore, the strongest acid-base pair is on the opposite side.

In this equation, the position of the equilibrium lies to the left. Which is the strongest acid in the system?



Answer is NH_3OH^+ .