Figure 0307

Representative Brønsted acid-base reactions.

. . . *Figure 0307 continued from previous page.*

The proton transfer reaction between water and sodium hydride

water acting as a Brønsted acid, is deprotonated by the hydride ion

sodium hydride acting as a Brønsted base, the hydride ion deprotonates the water

sodium hydroxide: the deprotonated water; conjugate base of water

hydrogen gas: the protonated hydride ion; conjugate acid of hydride

four equivalent expressions:
- water protonates hydride ion
- hydride ion deprotonates water
- water is deprotonated by hydride ion
- hydride ion is protonated by water

On the left-hand side of the first chemical equation (see previous page; commonly "the reactants," or the "starting materials"), both of the molecules are potential Brønsted acids and bases. The acetic acid struc-ture has 3 C-H bonds and 1 O-H bond (potential Brønsted acidic sites) and nbe pairs on both oxygen atoms (potential Brønsted basic sites). Water also has both features: 2 O-H bonds (acidic sites) and 2 nbe pairs (basic sites).

At this point in the discussion, you need the results to guide you in which of the possible proton transfer reactions has taken place, and this is found in the structures of the observed products and then comparing the two sides of the equation. Acetic acid is the Brønsted acid (the substance from which a proton is removed), and water is the Brønsted base (the substance that accepts the proton from acetic acid). The products of proton transfer are shown on the right-hand side of the equation and indicate this transfer. Acetate ion, which is formed by the loss of a proton from acetic acid, is the conjugate base of acetic acid, and the hydronium ion is the conjugate acid of water. Thinking about the reverse reaction (moving from the right- to left-hand side of the equation), the acetate ion can retrieve the proton from the hydronium ion to re-form acetic acid and water.

In the second equation, only water has a covalent bond involving a hydrogen atom, and so it is the only candidate with a potential Brønsted acid site. Sodium hydride is an ionic compound possessing the hydride ion. In this example, then, water is the Brønsted acid, and it is deprotonated by the hydride ion from sodium hydride, which is the only atom bearing a nbe pair to act as a Brønsted base. The products of the proton transfer reaction are hydroxide ion (the conjugate base of water) and hydrogen gas (the conjugate acid of hydride ion). In this reaction, the arrow is shown as a reaction on a one-way street. There is no opportunity for the hydroxide ion to take the proton back. The molecular hydrogen is a gas, and so it would bubble out of the reaction vessel. This is an example of how a reaction can shift completely to one side (in this case, towards the products) by the physical removal of one of the products from the reaction mixture. More generally, this is an example of Le Châtelier's Principle.

Read carefully the four statements associated with each of the examples in Figure 0307 listed as "four equivalent expressions." These statements are all synonymous ways of expressing the proton transfer reaction indicated by the structures.