# 3.5 FUNCTIONAL GROUPS

## TRY THIS ACTIVITY: BENDING WATER

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(a) hexane—no functional groups
alcohol—hydroxyl group, –OH
diethyl ether—an oxygen atom bonded to two alkyl groups
acetone—a carbonyl group, C=O

(b) A stream of hexane does not bend because it has no polar groups that are attracted to (or repelled by) a charged object. The stream of alcohol bends because the –OH group is polar and is strongly attracted to (or repelled by) the charged object. The stream of diethyl ether does not bend, or only very slightly, because the oxygen atom bonded to two alkyl groups is only slightly polar, and thus is only slightly affected, if at all, by a charged object. The carbonyl group in acetone is a polar group and thus causes the acetone molecules to be attracted to (or repelled by) the charged object, so the stream of liquid bends.

## SECTION 3.5 QUESTIONS

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### Understanding Concepts

1. A functional group is a structural arrangement of atoms that, because of their electronegativity and bonding type, imparts particular characteristics to the molecule.
2. C=C and C≡C bonds are more reactive than C–C bonds because the second and third bonds formed are weaker than the single bonds formed, and are thus more easily broken, making the multiple bonds more reactive.
3. In general, polar molecules have higher boiling points than less polar molecules because polar molecules have stronger intermolecular attractions that require more energy (higher temperatures) to overcome. Very large nonpolar molecules are affected by London dispersion forces that may cause their boiling points to be comparable to those of smaller polar molecules.
4. Functional groups can contain carbon–carbon multiple bonds, which are more reactive than single C–C bonds; single bonds between carbon and more electronegative atoms (e.g., O, N, or a halogen atom), which result in polar bonds and hydrogen bonding; and carbon double-bonded to oxygen, a highly polar bond.
5. (a) The –OH or –NH functional group raises the melting and boiling points of a compound because the increased polarity of the molecule increases intermolecular forces of attraction, requiring more energy to separate the molecules.
   (b) The functional group increases the solubility in polar solvents because –OH and –NH groups allow increased hydrogen bonding with polar solvents.
6. (a) –OH group; high solubility in water
   (b) carbon–carbon double bond; low solubility in water
   (c) carbonyl group, C=O; high solubility in water
   (d) –OH group and carbonyl group, C=O; high solubility in water
7. (a) $H_2O$, $NH_3$, $CH_4$
   (b) Water and ammonia are mutually soluble, but methane is not soluble in the other two compounds. The electronegativities of O, N, C, and H are 3.5, 3.0, 2.5, and 2.1, respectively. Thus, the O–H and N–H bonds in water and in ammonia are more polar than the C–H bonds in methane. The polar bonds in water and ammonia allow them to form hydrogen bonds. Thus, they are soluble in each other.
   (c) All three compounds may be considered organic because they are produced by living organisms (e.g., water by animals and plants, ammonia and methane by bacteria). According to the chemical definition of "organic," that is, containing carbon, only methane is organic.