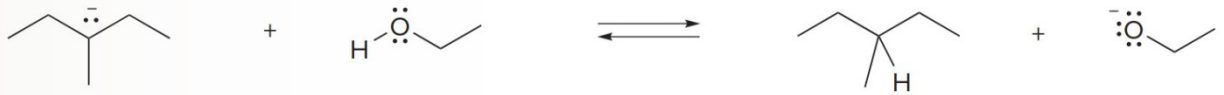
a. Draw the conjugate acid of each base: NH_3, Cl^-, $(CH_3)_2C{=}O$.

b. Draw the conjugate base of each acid: HBr, HSO_4^-, CH_3OH.

Determining the Acid, Base, Conjugate Acid, and Conjugate Base in a Reaction

Label the acid and base, and the conjugate acid and base, in the following reaction. Use curved arrow notation to show the movement of electron pairs.



A **B** **C** **D**

Solution

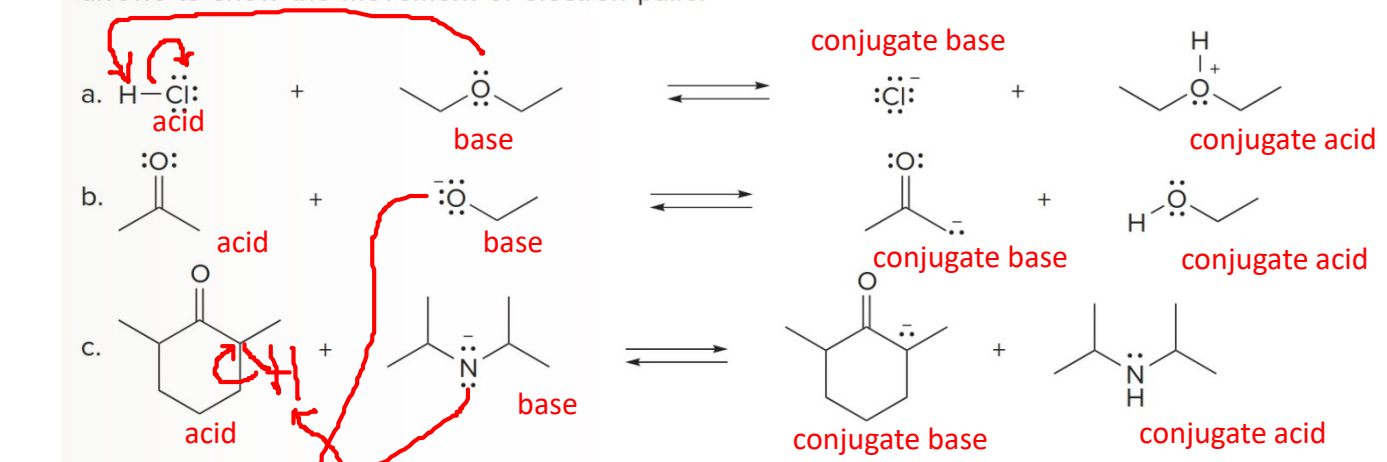
A is the base because it accepts a proton, forming its conjugate acid, **C. B** is the acid because it donates a proton, forming its conjugate base, **D.** Two curved arrows are needed because two electron pairs are involved. One shows that the lone pair on **A** bonds to a proton of **B,** and the second shows that the electron pair in the O–H bond remains on O.

A **B** **C** **D**

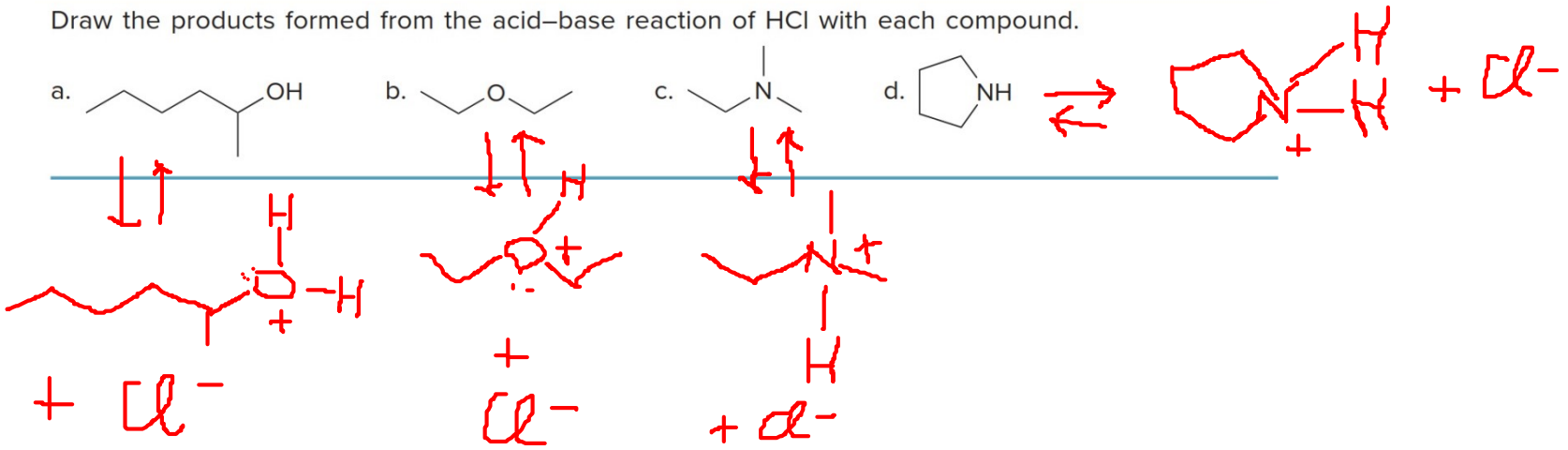
base **acid** **conjugate acid** **conjugate base**

The base gains H^+. **The acid loses H^+.**

Label the acid and base, and the conjugate acid and base, in the following reactions. Use curved arrows to show the movement of electron pairs.



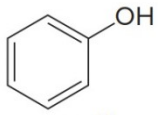
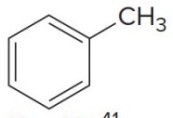
Draw the products formed from the acid–base reaction of HCl with each compound.



Which compound in each pair is the stronger acid?

a. $CH_3CH_2CH_3$ or CH_3CH_2OH

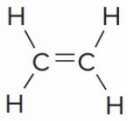
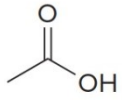
$pK_a = 50$ $pK_a = 16$

b.  or 

$K_a = 10^{-10}$ $K_a = 10^{-41}$

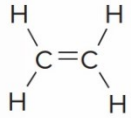
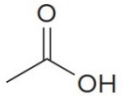
Using pK_a Values to Determine Relative Acidity and Basicity

Rank the following compounds in order of increasing acidity, and then rank their conjugate bases in order of increasing basicity.

Solution

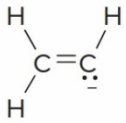
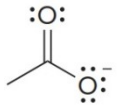
Use the pK_a values in Table 2.1 and the rule: **the lower the pK_a, the stronger the acid.**

$pK_a = 44$ $pK_a = 4.8$ $pK_a = -7$

Increasing acidity

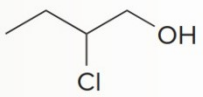
Remove a proton to draw the conjugate bases. Because strong acids form weak conjugate bases, the **basicity of conjugate bases increases with increasing pK_a** of their acids.

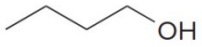
Increasing basicity

Sample Problem 2.7 Determining the Relative Acidity of Compounds

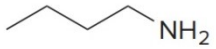
Rank the following compounds in order of increasing acidity of their most acidic hydrogen atom.



A



B

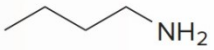


C

Solution

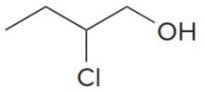
[1] Compounds **A, B,** and **C** contain C—H, N—H, and O—H bonds. Because acidity increases left-to-right across a row of the periodic table, the **O—H bonds are most acidic.** Compound **C** is thus the least acidic because it has *no* O—H bonds.

[2] The only difference between compounds **A** and **B** is the presence of an electronegative Cl in **A.** The Cl atom stabilizes the conjugate base of **A,** making it more acidic than **B.** Thus,



C

B



A

Increasing acidity