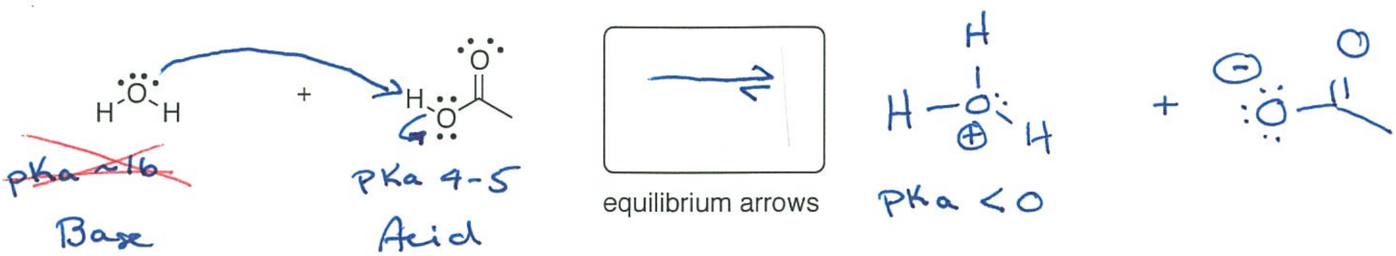
ACID/BASE CHEMISTRY (cont):

Equilibrium. The direction of the equilibrium depends of the relative strength of the acid and the conjugate acid (which indirectly points to the strength of the base). Practice, below:



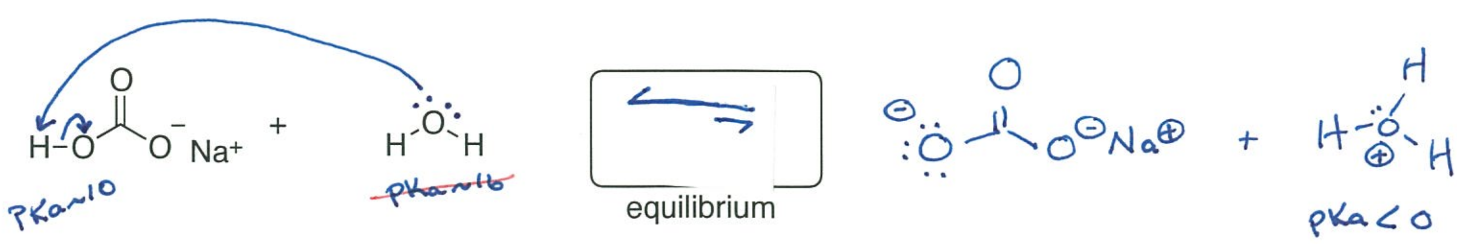
1. *Identify the acid and base in a chemical reaction.* Determine the approximate pKa of each molecule. If it is not obvious, the molecule with the LOWER of the two pKa values will be the acid, and the other molecule will be the base. Only write the pKa value of the ACID underneath the acid, but do not write the other value underneath the base.

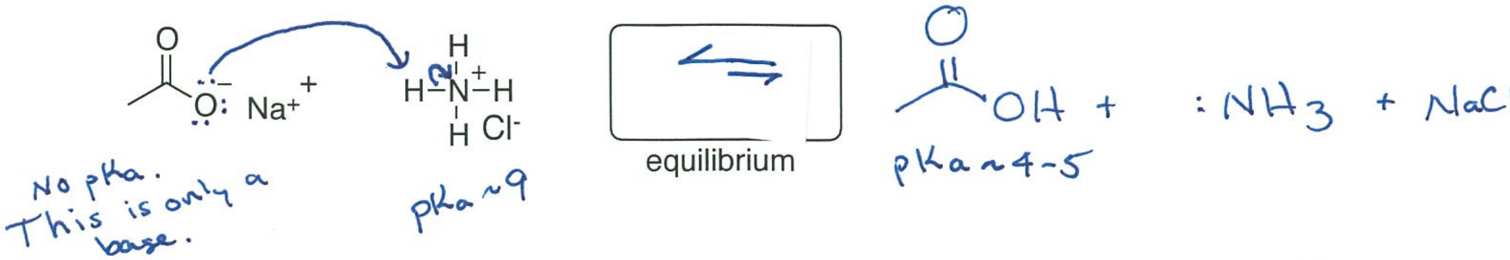
2. *Draw an arrow-pushing mechanism for the reaction.* Find a pair of electrons on your base and go after the most acidic (δ+) hydrogen. When the electrons overlap the hydrogen atom, only the PROTON gets removed; BOTH electrons in the sigma bond (between the H and O in this example) stay behind to form an additional lone pair on the newly formed conjugate base.

3. *Predict and draw the product(s) formed.* What do your arrows show was made? An arrow drawn from electrons to an atom means a new covalent bond was made. An arrow from a bond to an atom means that a covalent bond was broken and a lone pair of electrons was left behind. Draw these two products on the right side of the equation. Electron book-keeping is very important; watch for atoms that may or may not be charged. The net charge on the left side of the equation will be the same as the net charge on the right side of the equation.

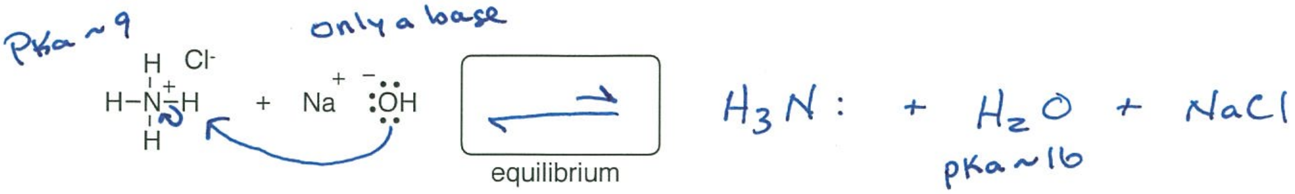
4. *Predict the direction of the acid-base equilibria.* Look up (or estimate) the pKa of the conjugate acid and write it down under that molecule. The equilibrium will *always* be preferred in the direction toward the acid with the higher pKa. In other words, the stronger acid will always prefer to donate it's proton. Show these arrows in the empty box, above.

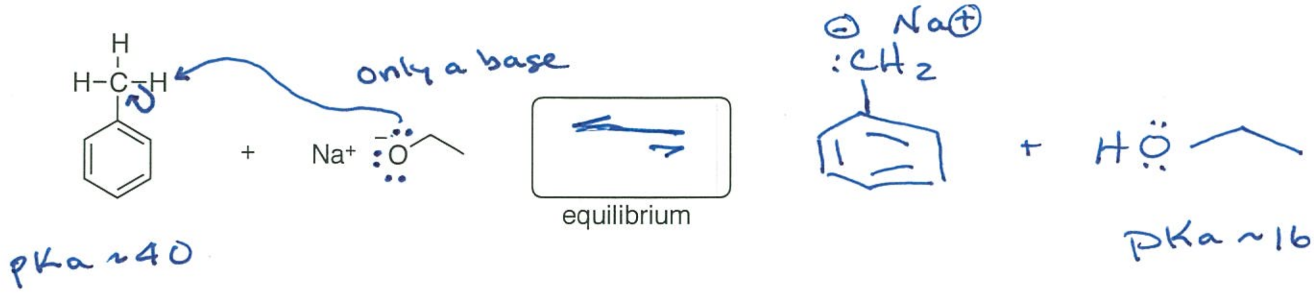
Try doing the same to these reactions (adding lone electron pairs to the base may be helpful):





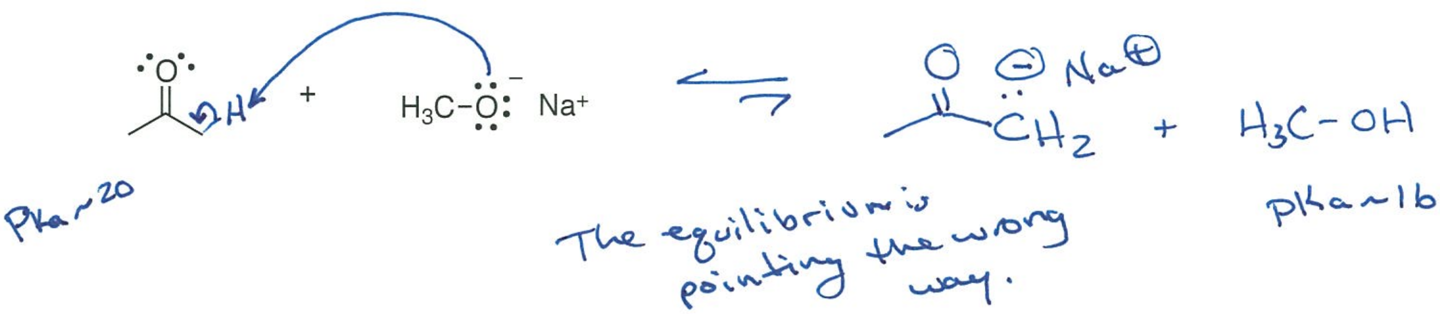
Here's two more to try:





Question: Is sodium methoxide strong enough a base to completely deprotonate acetone? NO.

To answer this question, draw the products and indicate where the equilibrium lies (below).

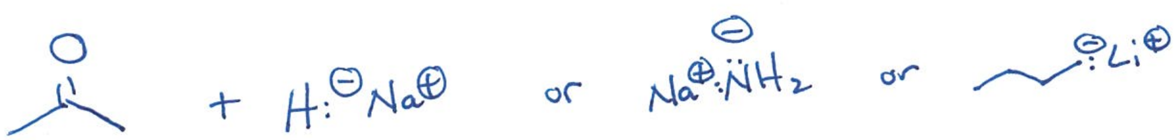


You should conclude that sodium methoxide is NOT a strong enough base.

Question: What base WOULD be strong enough?

In order for a base to be strong enough to push the equilibrium to the right, the pKa of it's conjugate acid (on the right side of the equation) must be greater than that of the acid (on the left side of the equation).

To push the equilibrium far enough to the right so that the reaction is nearly irreversible (complete deprotonation), the pKa of a base's conjugate acid should be at least 4 or 5 units higher than the pKa of the acid.



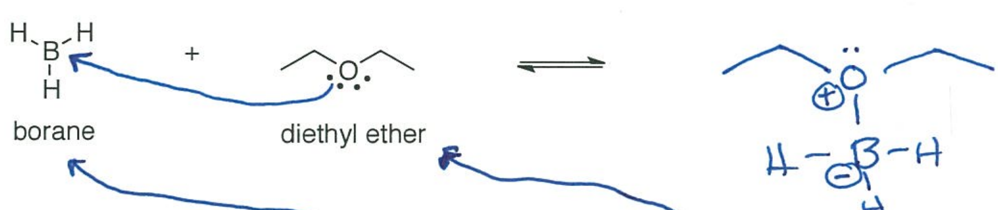
Here's a unique acid-base reaction - Fill in the blanks:

1. How many valence electrons does boron have when neutral (consult a periodic table)? ___3___

2. Because of this, if each electron pairs up with another electron from an incoming atom (like hydrogen), how many bonds will boron have when neutral? ___3___

3. Given that boron is in the second row, ~~wow~~ how many electrons can fit into the valence shell of boron? ___8___

4. Good. Now find two electrons to put two into the valence shell of boron (draw the curved-arrow mechanism), and draw what you made on the right side of the equilibrium arrows. Don't forget to include atomic charges:



Which molecule acted as a Lewis acid, and which acted as a Lewis base?

This example highlights the fact that not all Lewis acids are Brønsted-Lowry acids, and vice versa.