Acid Base Chemistry

1. Foundation knowledge
2. The pH scale
3. The pH of Water
4. Acids
5. Bases
6. Acid base titrations
7. Relative acidity and basicity – competition for H+
    a. pKa and pKb of conjugate acids and bases
    b. Competition for H+

pK_a and pK_b of **conjugate** acids and bases

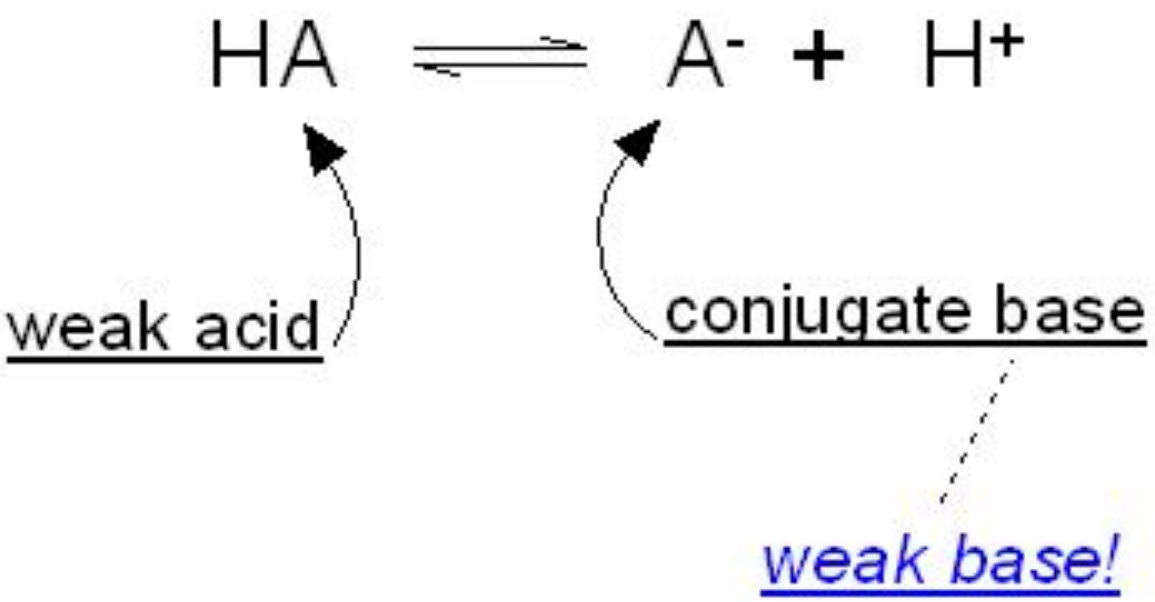
We are learning to:

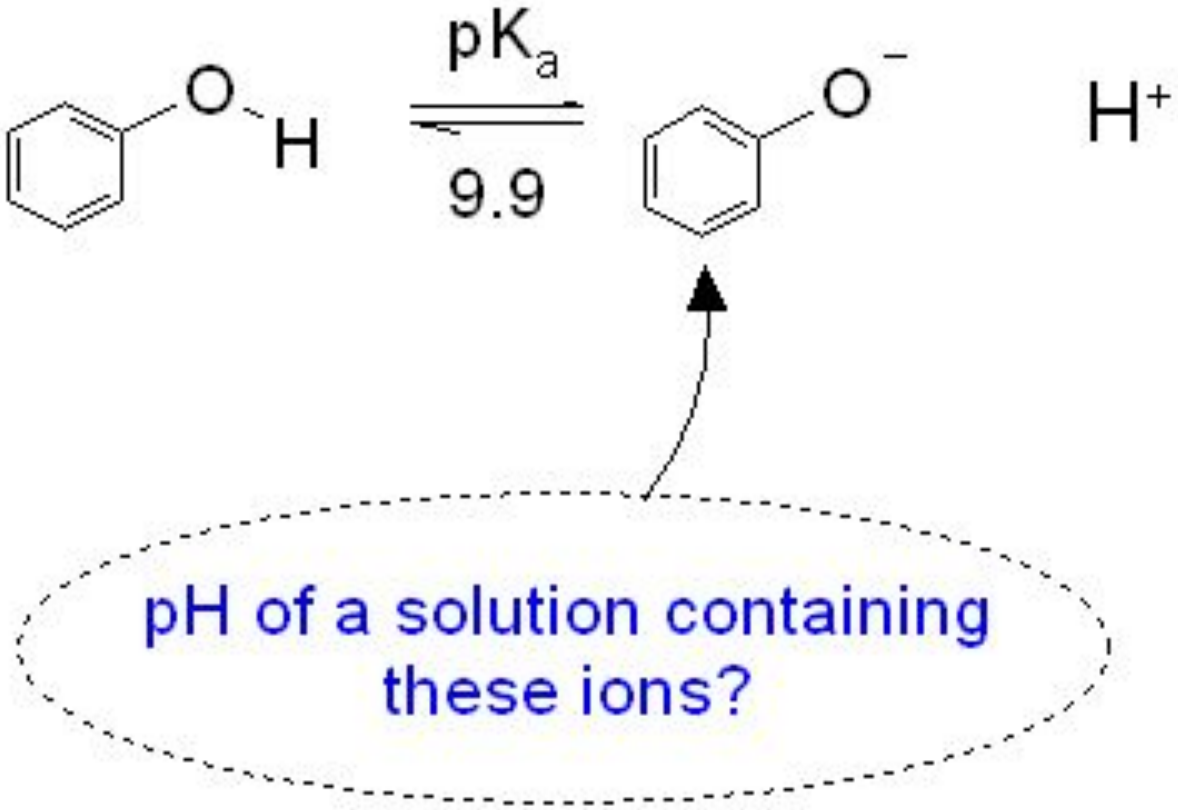
work out pK_b from pK_a

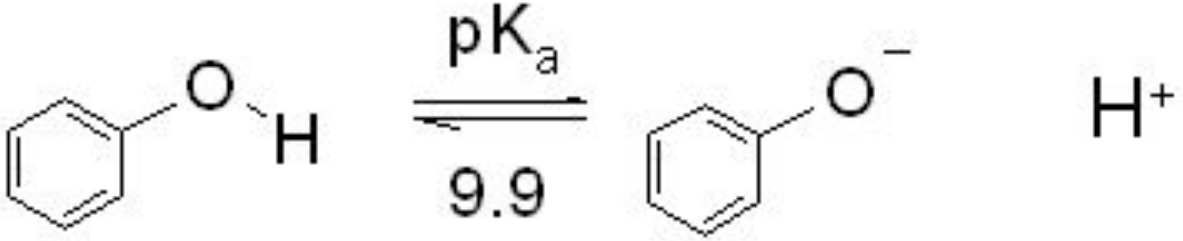
" " pK_a from pK_b

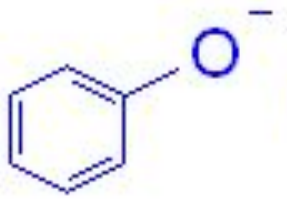
$pK_a + pK_b = 14$

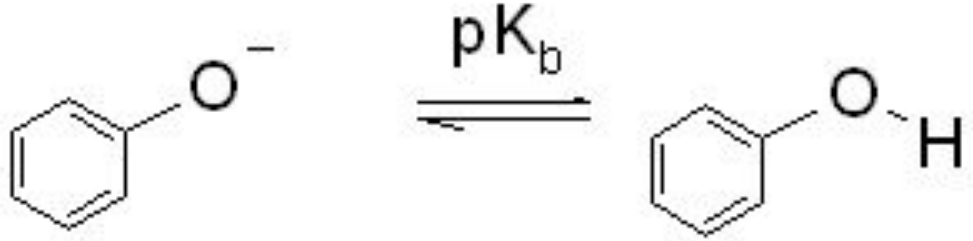
calculate pH for conjugate acids and bases


HA ⇌ A⁻ + H⁺
weak acid
conjugate base
weak base!


pK$_a$
9.9
O
H
O$^-$
H$^+$
pH of a solution containing these ions?



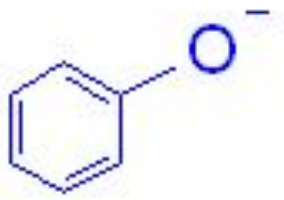
What is the pH of 0.1 moldm^{-3}  Na$^+$?

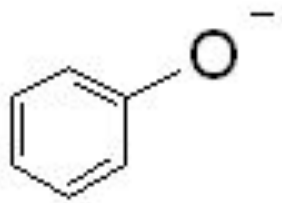
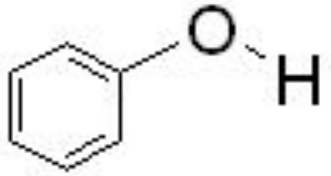


$$pK_a + pK_b = 14$$

$$\therefore \quad pK_b = 14 - 9.9$$

$$= 4.1$$

What is the pH of 0.1 moldm^{-3}  Na^+?

 $\underset{4.1}{\overset{pK_b}{\rightleftharpoons}}$  HO^-

$$[^-OH] = \sqrt{K_b\ [B]}$$

$$= \sqrt{10^{-4.1} \times 0.1}$$

$$= 2.88 \times 10^{-3}\ \text{moldm}^{-3}$$

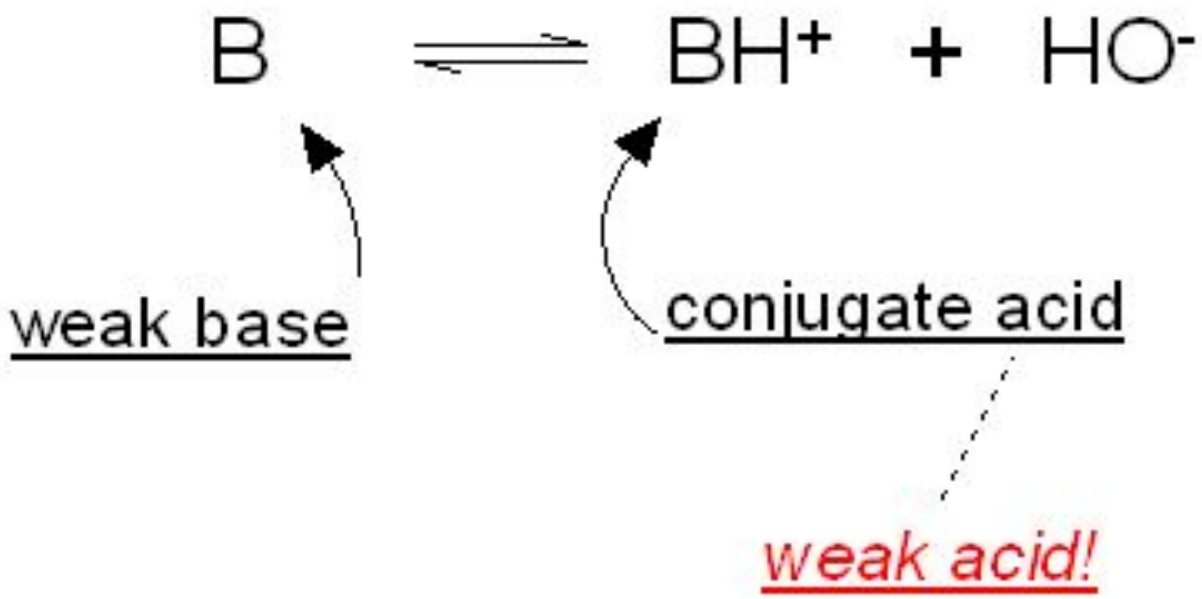
$$[^-OH] = 2.88 \times 10^{-3}\ \text{moldm}^{-3}$$

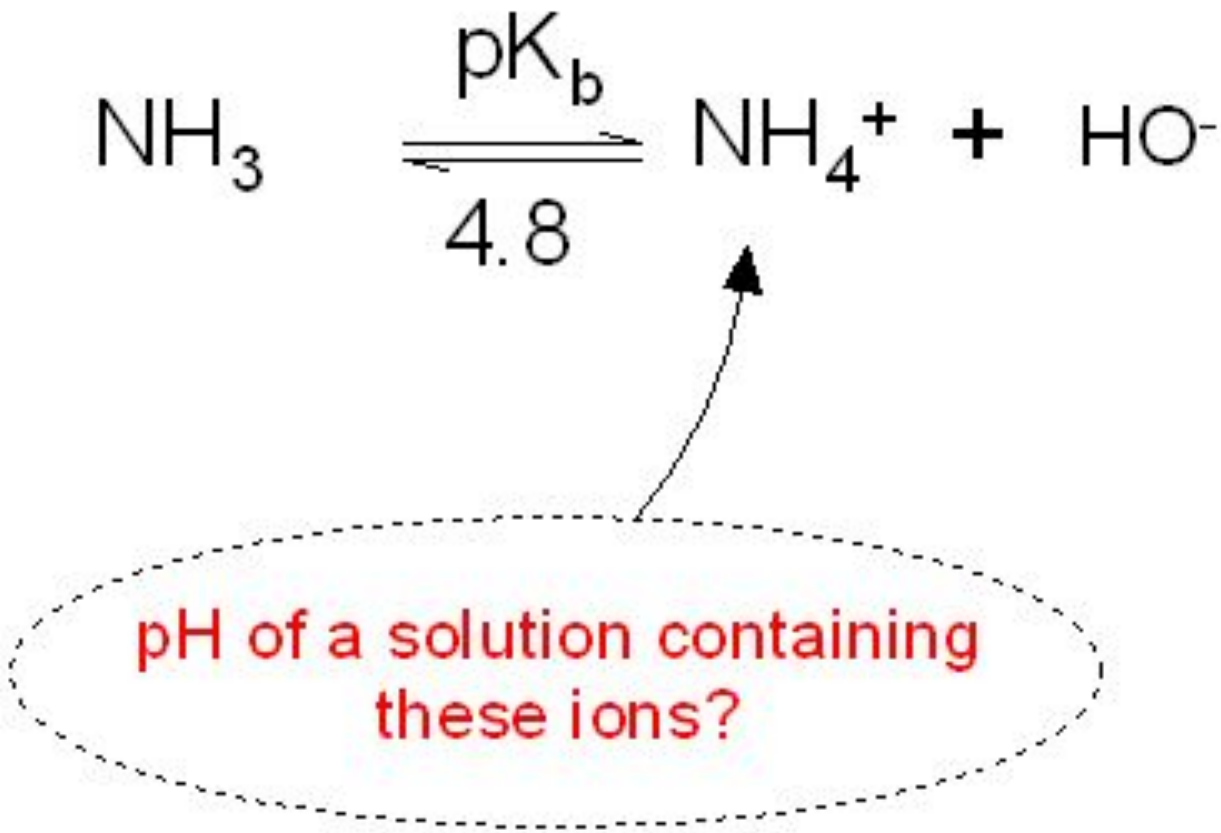
$$\therefore\ pOH = -\log 2.88 \times 10^{-3}$$

$$= 2.6$$

$$pH + pOH = 14 \quad (298K)$$

$$\therefore\ \underline{\underline{pH = 11.4}}$$


B
BH+ + HO-
weak base
conjugate acid
weak acid!


$NH_3 \rightleftharpoons NH_4^+ + HO^-$
pK_b
4.8
pH of a solution containing these ions?

$$NH_3 \underset{4.8}{\overset{pK_b}{\rightleftharpoons}} NH_4^+ + HO^-$$

What is the pH of 0.1 moldm^{-3} $NH_4^+ Cl^-$?

$$NH_4^+ \overset{pK_a}{\rightleftharpoons} NH_3 + H^+$$

$$\boxed{pK_a + pK_b = 14}$$

$$\therefore \quad pK_a = 14 - 4.8$$

$$= 9.2$$

What is the pH of 0.1 moldm^{-3} $NH_4^+ Cl^-$?

$$NH_4^+ \underset{9.2}{\overset{pK_a}{\rightleftharpoons}} NH_3 + H^+$$

$$[H^+] = \sqrt{K_a\ [AH]}$$

$$= \sqrt{10^{-9.2} \times 0.1}$$

$$= 7.94 \times 10^{-6}\ \text{moldm}^{-3}$$

$$\therefore\ pH = -\log 7.94 \times 10^{-6}$$

$$= 5.1$$

Proving $pK_a + pK_b = 14$

$$HA \overset{K_a}{\rightleftharpoons} H^+ + A^- \qquad K_a = \frac{[H^+][A^-]}{[HA]}$$

$$A^- \overset{K_b}{\rightleftharpoons} AH + HO^- \qquad K_b = \frac{[AH][HO^-]}{[A\text{-}]}$$

$$\therefore K_a \times K_b = \frac{[H^+][A^-]}{[HA]} \cdot \frac{[AH][HO^-]}{[A^-]}$$

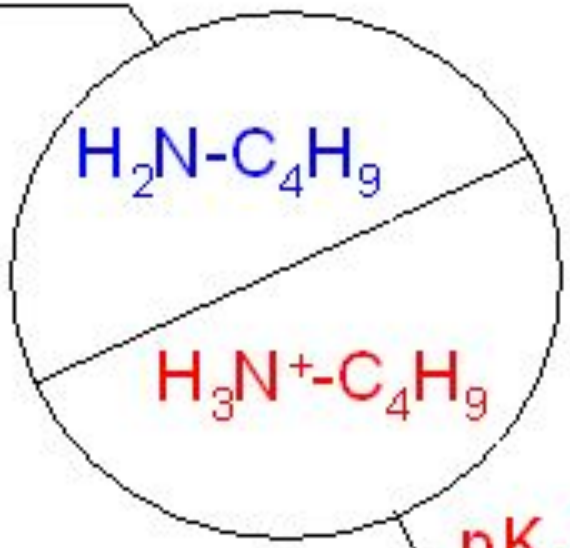
$$= [H^+][HO^-] \quad = K_w !$$

$$\therefore K_a \times K_b = K_w$$

$$pK_a + pK_b = pK_w$$

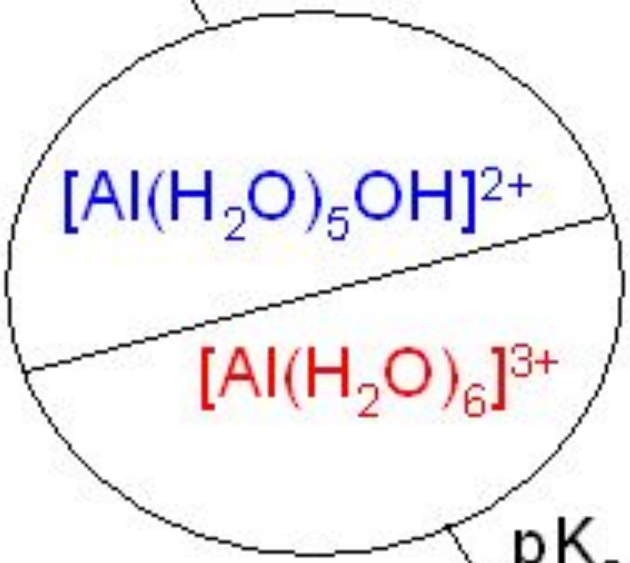
$$pK_a + pK_b = 14 \ (298K)$$

$pK_b = 3.2$



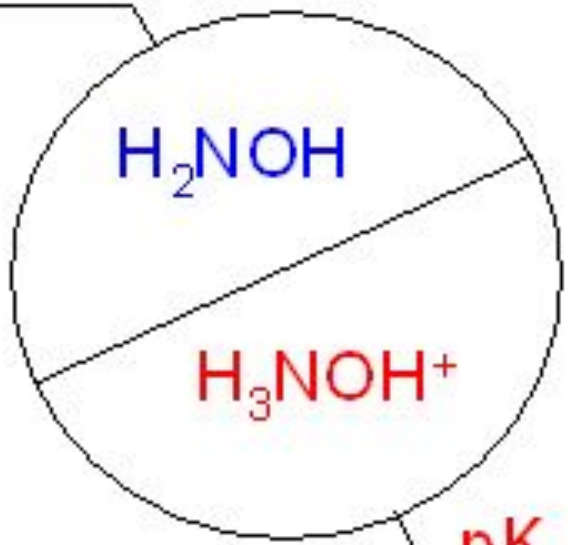
$pK_a =$

$pK_b =$



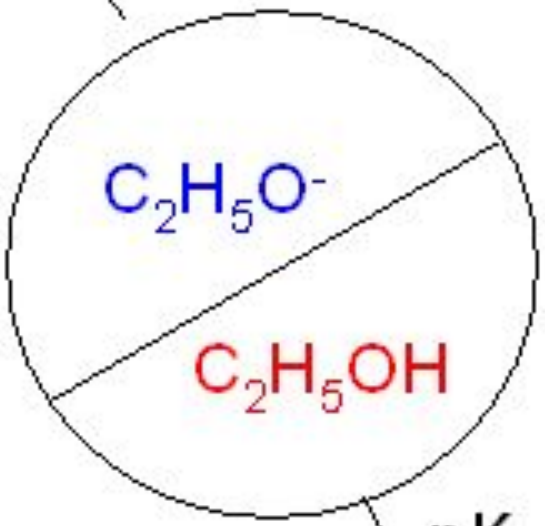
$pK_a = 5$

$pK_b = 8$

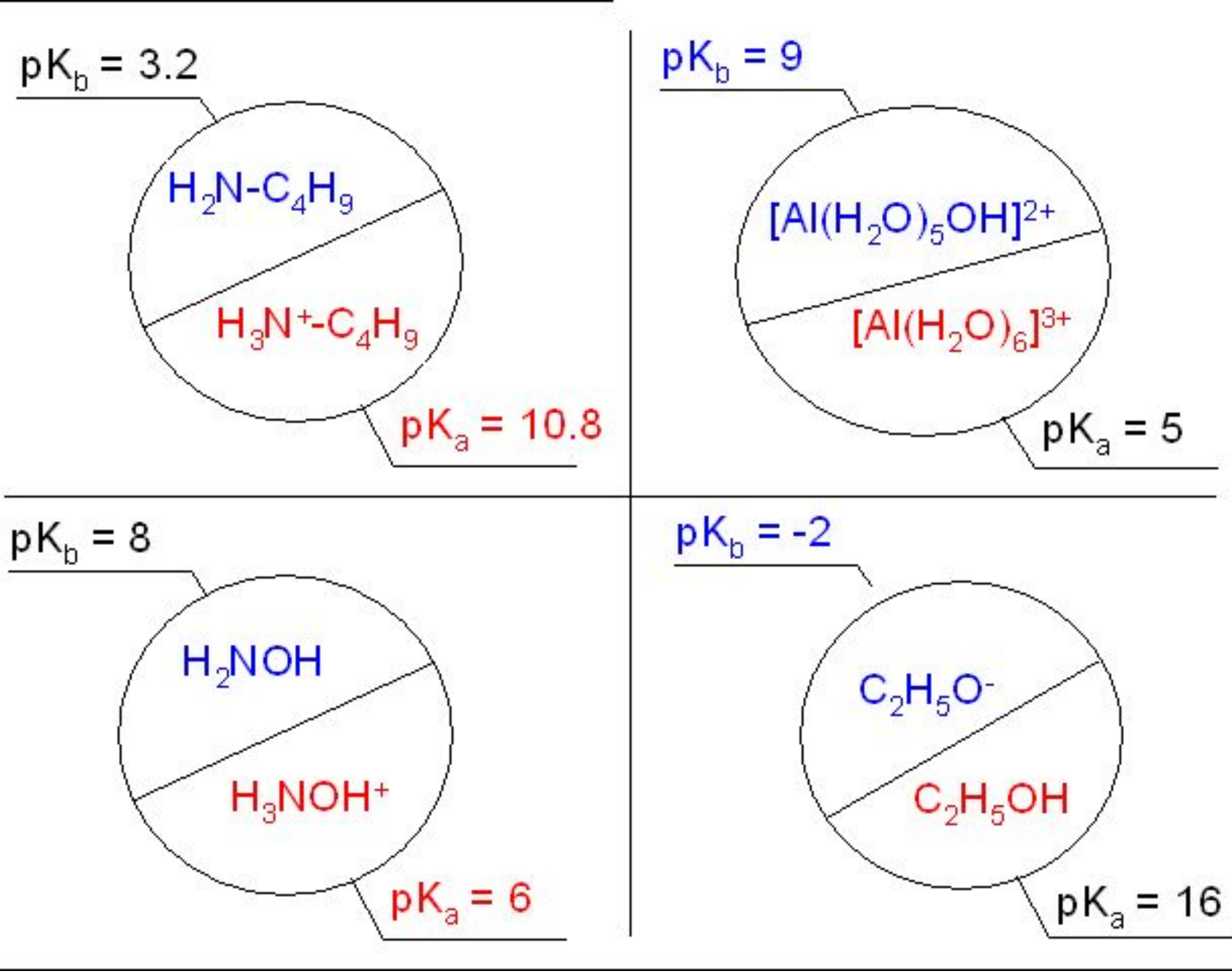


$pK_a =$

$pK_b =$



$pK_a = 16$


pK$_b$ = 3.2
H$_2$N-C$_4$H$_9$
H$_3$N$^+$-C$_4$H$_9$
pK$_a$ = 10.8
pK$_b$ = 9
[Al(H$_2$O)$_5$OH]$^{2+}$
[Al(H$_2$O)$_6$]$^{3+}$
pK$_a$ = 5
pK$_b$ = 8
H$_2$NOH
H$_3$NOH$^+$
pK$_a$ = 6
pK$_b$ = -2
C$_2$H$_5$O$^-$
C$_2$H$_5$OH
pK$_a$ = 16