1. What is the $pK_a$ of the conjugate acid of hydrazine, given that the $pK_b$ of hydrazine is 5.77? Write the formula of the conjugate acid of hydrazine.

2. The pH of 0.800 M aqueous benzenesulfonic acid is 0.51. What is the value of $K_a$ for benzenesulfonic acid?
   A) 0.19
   B) 0.12
   C) 0.90
   D) 0.44
   E) 0.51

3. Arrange the following species in order of decreasing $pK_a$:

   ![Chemical structures](image)

   A) H$_2$N-SO$_2$F
   B) H$_2$N-SO$_2$Ph
   C) H$_2$N-C(Ph)-CO
   D) H$_2$N-CH$_3$
   E) H$_2$N-C(Ph)

4. What is the pH of an aqueous solution that is 0.60 (CH$_3$)$_3$N ($K_b = 6.5 \times 10^{-5}$) and 0.95 M (CH$_3$)$_3$NHCl?
   A) 4.39
   B) 10.01
   C) 3.99
   D) 9.81
   E) 9.61
Answer Key

1. $pK_a = 8.23$ for $\text{N}_2\text{H}_3^+$
2. A
3. 
4. E
Quiz 4 Answer Key

1. The conjugate acid of hydrazine is $\text{H}_2\text{N-NH}_3^+$. Its $pK_a = 14 - 5.77 = 8.23$

2. pH of 0.51 translates into $[\text{H}^+] = 0.309$ M.

\[
x^2/(0.800-x) = K_a \\
0.309^2/(0.800-0.309) = K_a \approx 0.19
\]

3. Decreasing $pK_a$ means increasing acidity. $pK_a$ decreases as follows:
   
   \[D > C > E > B > A\]

4. An aqueous solution containing a mixture of Me$_3$N and Me$_3$NHCl can be treated as a buffer. The pH of this solution:

\[
[\text{H}^+] = K_a \times [\text{HA}]/[\text{A}^-], \text{ where HA is the conjugate acid of the buffer, A}^- \text{ is the conjugate base, and } K_a \text{ is the acidity constant for the acid.}
\]

\[
K_a(\text{Me}_3\text{NH}^+) = K_w/K_b(\text{Me}_3\text{N}) = 1 \times 10^{-14}/(6.5 \times 10^{-5}) \approx 1.5 \times 10^{-10}
\]

So,

\[
[\text{H}^+] = 1 \times 10^{-14}/(6.5 \times 10^{-5}) \times 0.95/0.60 \approx 2.4 \times 10^{-10} \quad \text{pH} = 9.61
\]