Marks 5

- Consider the following equation.

$$HBrO(aq) + NH_3(aq) \rightleftharpoons BrO^-(aq) + NH_4^+(aq)$$

Name all of the species in this equation.

HBrO	**hypobromous acid**
BrO^-	**hypobromite ion**
NH_3	**ammonia**
NH_4^+	**ammonium ion**

Complete the following table by giving the correct pK_a or pK_b value where it can be calculated. Mark with a cross (✕) those cells for which insufficient data have been given to calculate a value.

Species	HBrO	NH_3	BrO^-	NH_4^+
pK_a of acid	8.64	✕	✕	**9.24**
pK_b of base	✕	4.76	**5.36**	✕

Determine on which side (left or right hand side) the equilibrium for the reaction above will lie. Provide a brief rationale for your answer.

The reaction is the sum of the acid-base equilibra for HBrO and NH_3:

$HBrO(aq) \rightarrow H^+(aq) + BrO^-(aq)$	**$K_a(HBrO) = 10^{-8.64}$**
$H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$	**$K(NH_3) = \frac{1}{K_a(NH_4^+)} = 10^{+9.24}$**
$HBrO(aq) + NH_3(aq) \rightarrow BrO^-(aq)$	**$K = K_a(HBrO) \times K(NH_3)$**

Hence, $K = (10^{-8.64}) \times (10^{+9.24}) = 10^{+0.64} = 4.4$. As $K > 1$, the reaction favours products.