Weak acid - Strong Base

20.00 mL of 0.2000 M HBrO is titrated with 0.1000 M NaOH.
What is pH:

a) before any base is added
b) when [HBrO] = [BrO⁻]
c) at the equivalence point
d) when moles of $OH^-$ added is 2x the moles of HBrO initially present

$K_a$ of HBrO = $2.3 \times 10^{-9}$

e) Also, sketch the titration curve

a) Before base:

$$HBrO_{(aq)} + H_2O_{(l)} \rightleftharpoons BrO^-_{(aq)} + H_3O^+_{(aq)}$$

$$K_a = \frac{[BrO^-][H_3O^+]}{[HBrO]}$$ $x = [H_3O^+] = [BrO^-] \Rightarrow x^2$ in ka expression

$$K_a = \frac{x^2}{[HBrO]}$$ $\therefore [H_3O^+] \approx \sqrt{[HBrO]\,K_a} = \sqrt{(0.2000)(2.3\times10^{-9})}$

$= 2.1 \times 10^{-5}$ M

$$pH = -\log[H_3O^+] = -\log(2.1\times10^{-5}) = 4.68$$

pH = 4.68

b) [HBrO] = [BrO⁻]

$$pH = pK_a + \log\frac{[A^-]}{[HA]} \Rightarrow [H_3O^+] = K_a \times \frac{[HBrO]}{[BrO^-]}$$

HA

A⁻

$$[H_3O^+] = 2.3\times10^{-9} \times \frac{[HBrO]}{[BrO^-]} = 2.3\times10^{-9} \times 1$$

Since [HBrO]=[BrO⁻] the ratio is 1 regardless of the actual numbers for concentration

$= 2.3 \times 10^{-9}$ M

$$pH = -\log(2.3\times10^{-9}) = 8.64$$

pH = 8.64