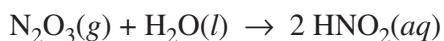


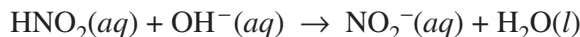
2. A student investigates the reactions of nitrogen oxides. One of the reactions in the investigation requires an equimolar mixture of  $\text{NO}(g)$  and  $\text{NO}_2(g)$ , which the student produces by using the reaction represented above.
- (b) The student begins with an equimolar mixture of  $\text{NO}(g)$  and  $\text{NO}_2(g)$  in a rigid reaction vessel and the mixture reaches equilibrium at 298 K.
- Calculate the value of the equilibrium constant,  $K$ , for the reaction at 298 K.
  - If both  $P_{\text{NO}}$  and  $P_{\text{NO}_2}$  in the vessel are initially 1.0 atm, will  $P_{\text{N}_2\text{O}_3}$  at equilibrium be equal to 1.0 atm? Justify your answer.
- (c) The student hypothesizes that increasing the temperature will increase the amount of  $\text{N}_2\text{O}_3(g)$  in the equilibrium mixture. Indicate whether you agree or disagree with the hypothesis. Justify your answer.

$\text{N}_2\text{O}_3(g)$  reacts with water to form nitrous acid,  $\text{HNO}_2(aq)$ , a compound involved in the production of acid rain. The reaction is represented below.

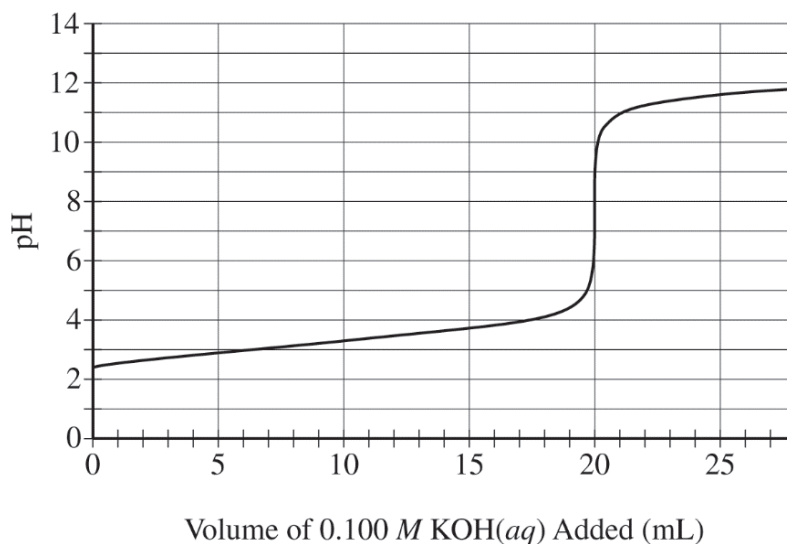


- Based on your completed diagram above, identify the hybridization of the nitrogen atom in the  $\text{HNO}_2$  molecule.

To produce an aqueous solution of  $\text{HNO}_2$ , the student bubbles  $\text{N}_2\text{O}_3(g)$  into distilled water. Assume that the reaction goes to completion and that  $\text{HNO}_2$  is the only species produced. To determine the concentration of  $\text{HNO}_2(aq)$  in the resulting solution, the student titrates a 100. mL sample of the solution with 0.100 M  $\text{KOH}(aq)$ . The neutralization reaction is represented below.



The following titration curve shows the change in pH of the solution during the titration.



- (e) Use the titration curve and the information above to
- determine the initial concentration of the  $\text{HNO}_2(aq)$  solution
  - estimate the value of  $\text{p}K_a$  for  $\text{HNO}_2(aq)$
- (f) During the titration, after a volume of 15 mL of 0.100 M  $\text{KOH}(aq)$  has been added, which species,  $\text{HNO}_2(aq)$  or  $\text{NO}_2^-(aq)$ , is present at a higher concentration in the solution? Justify your answer.