

Answer on Question #75825, Chemistry / General Chemistry

A 1.00 liter solution contains 0.37 M ammonia and 0.28 M ammonium iodide.

If 0.14 moles of perchloric acid are added to this system, indicate whether the following statements are true or false.

(Assume that the volume does not change upon the addition of perchloric acid.)

- A. The number of moles of NH_3 will remain the same.
- B. The number of moles of NH_4^+ will remain the same.
- C. The equilibrium concentration of H_3O^+ will decrease.
- D. The pH will decrease.
- E. The ratio of $[\text{NH}_3] / [\text{NH}_4^+]$ will decrease.

Solution

$$V_{\text{solution}} = 1\text{L}$$

$$c(\text{NH}_3) = 0.37\text{M}$$

$$c(\text{NH}_4\text{I}) = 0.28\text{M}$$

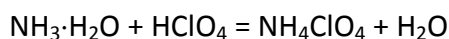
$$n(\text{HClO}_4) = 0.14\text{ moles}$$

- A. The number of moles of NH_3 will remain the same – false

$$c(\text{NH}_3) = 0.37\text{M i.e. } 0.37\text{ mol of } \text{NH}_3\text{ in } 1\text{ L of solution.}$$

When ammonia gets in water it forms $\text{NH}_3 \cdot \text{H}_2\text{O}$

When perchloric acid is added the chemical reaction takes place:



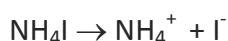
According to equation $n(\text{NH}_3 \cdot \text{H}_2\text{O}) = n(\text{HClO}_4)$.

$n(\text{NH}_3 \cdot \text{H}_2\text{O}) = 0.37\text{ moles}$, $n(\text{HClO}_4) = 0.14\text{ moles} \Rightarrow n(\text{NH}_3 \cdot \text{H}_2\text{O}) > n(\text{HClO}_4) \Rightarrow \text{HClO}_4$ is a limiting reactant.

$n(\text{NH}_3 \cdot \text{H}_2\text{O})$ expended in reaction is 0.14 moles, $n(\text{NH}_3 \cdot \text{H}_2\text{O})$ left after reaction is $0.37 - 0.14 = 0.23\text{ mol}$.

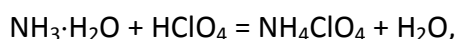
- B. The number of moles of NH_4^+ will remain the same – false.

Ions NH_4^+ in initial solution are formed in the process of dissociation of NH_4I :

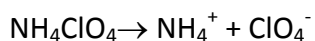


$$n(\text{NH}_4^+) = n(\text{NH}_4\text{I}) = 0.28 \text{ mol.}$$

In new solution a chemical reaction takes place:



where NH_4ClO_4 is formed. This salt dissociate in water and gives NH_4^+ :



$n(\text{NH}_4^+) = n(\text{NH}_4\text{ClO}_4) = 0.14 \text{ mol}$ (HClO_4 is a limiting reactant, according to chemical equation $n(\text{HClO}_4) = n(\text{NH}_4\text{ClO}_4) = 0.14 \text{ mol}$).

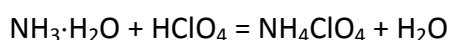
$$n_{\text{total}} = 0.28 + 0.14 = 0.42 \text{ (mol)}.$$

- C. The equilibrium concentration of H_3O^+ will decrease – false.

Initial solution: ammonia solution is basic, $\text{pH} > 7$



When perchloric acid is added the chemical reaction takes place:



After reaction: $c(\text{NH}_3 \cdot \text{H}_2\text{O}) = 0.37 - 0.14 = 0.23 \text{ mol/L}$

$$c(\text{HClO}_4) = 0$$

$$c(\text{NH}_4\text{ClO}_4) = 0.14 \text{ mol/L}$$

In initial solution $c(\text{NH}_3 \cdot \text{H}_2\text{O}) = 0.37 \text{ mol/L}$

We can see that concentration of ammonia decreased, consequently $c(\text{OH}^-)$ decreased but $c(\text{H}^+)$ increased as $[\text{H}^+] \cdot [\text{OH}^-] = 10^{-14}$ is constant, when concentration of OH^- decreases concentration of H^+ increases.

H^+ exists in water in form of H_3O^+ .

- D. The pH will decrease – true.

$\text{pH} = -\lg[\text{H}^+]$. As concentration of H^+ increases pH decreases.

- E. The ratio of $[\text{NH}_3] / [\text{NH}_4^+]$ will decrease – true.

In initial solution: $c(\text{NH}_3) = 0.37 \text{ mol/L}$, $c(\text{NH}_4^+) = 0.28 \text{ mol/L}$, then $[\text{NH}_3]/[\text{NH}_4^+] = 0.37/0.28 = 1.32$.

In new solution: $c(\text{NH}_3) = 0.23 \text{ mol/L}$, $c(\text{NH}_4^+) = 0.42 \text{ mol/L}$, then $[\text{NH}_3]/[\text{NH}_4^+] = 0.23/0.42 = 0.55$

$$0.55 < 1.32$$

Answer: A – false

B- false

C- false

D – true

E - true

Answer provided by [AssignmentExpert.com](https://www.assignmentexpert.com)