

Answer on Question #72027, Chemistry / General Chemistry :

What is the pH of a solution that has an equal concentration of H^+ and OH^- ions? .

Solution.

$$[H^+] = [OH^-]$$

$pH = ?$

pH is defined as the decimal logarithm of the reciprocal of the hydrogen ion activity, a_{H^+} , in a solution.

pOH is sometimes used as a measure of the concentration of hydroxide ions, OH^- . pOH values are derived from pH measurements. The concentration of hydroxide ions in water is related to the concentration of hydrogen ions by:

$$[OH^-] = \frac{K_{H_2O}}{[H^+]}$$

We have an equal concentration of H^+ and OH^- ions:

$$[OH^-] = [H^+]$$

And:

$$[H^+] = \frac{K_{H_2O}}{[H^+]}$$

$$[H^+]^2 = K_{H_2O} = 10^{-14}$$

$$[H^+] = \sqrt{K_{H_2O}} = \sqrt{10^{-14}} = 10^{-7}$$

pH:

$$pH = -\log[H^+] = -\log 10^{-7} = 7$$

$$pH = 7$$

Pure water is neutral, $pH = 7$. When an acid is dissolved in water, the pH will be less than 7 (25 °C). When a base, or alkali, is dissolved in water, the pH will be greater than 7. A solution of a strong acid, such as hydrochloric acid, at concentration 1 mol dm^{-3} has a pH of 0. A solution of a strong alkali, such as sodium hydroxide, at concentration 1 mol/l, has a pH of 14. Thus, measured pH values will lie mostly in the range 0 to 14, though negative pH values and values above 14 are entirely possible. Since pH is a logarithmic scale, a difference of one pH unit is equivalent to a tenfold difference in hydrogen ion concentration.

The pH of neutrality is not exactly 7 (25 °C), although this is a good approximation in most cases. Neutrality is defined as the condition where $[H^+] = [OH^-]$ (or the activities are equal). Since self-

ionization of water holds the product of these concentration $[H^+] \times [OH^-] = K_w$, it can be seen that at neutrality $[H^+] = [OH^-] = \sqrt{K_w}$, or $pH = pK_w/2$. pK_w is approximately 14 but depends on ionic strength and temperature, and so the pH of neutrality does also. Pure water and a solution of NaCl in pure water are both neutral, since dissociation of water produces equal numbers of both ions. However the pH of the neutral NaCl solution will be slightly different from that of neutral pure water because the hydrogen and hydroxide ions' activity is dependent on ionic strength, so K_w varies with ionic strength.

Answer: pH = 7