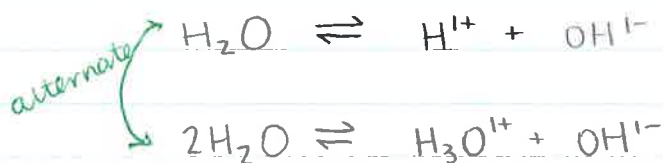


Jan 21stA Special Equilibrium !!!!

$$K_w = [\text{H}^+][\text{OH}^-]$$

water

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$$

$$K_w = 1 \times 10^{-14} \text{ @ } 25^\circ\text{C}$$

Provided:

1. $\text{pH} = -\log_{10} [\text{H}^+]$

2. $\text{pOH} = -\log_{10} [\text{OH}^-]$

3. $[\text{H}^+] = 10^{-\text{pH}}$

4. $[\text{OH}^-] = 10^{-\text{pOH}}$

5. $K_w = [\text{H}^+][\text{OH}^-]$

$$1 \times 10^{-14} = [\text{H}^+][\text{OH}^-]$$

$$\log 1 \times 10^{-14} = \log [\text{H}^+][\text{OH}^-]$$

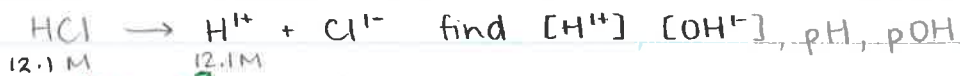
$$-14 = \log [\text{H}^+] + \log [\text{OH}^-]$$

$$14 = -\log [\text{H}^+] + (-\log [\text{OH}^-]) \quad * \quad -\log [\text{H}^+] = \text{pH}, -\log [\text{OH}^-] = \text{pOH}$$



6. $14 = \text{pH} + \text{pOH}$

ex - strong acid or base calculation (gr. 11)



$$\therefore [\text{H}^+] = 12.1 \text{ M}$$



$$\text{pH} = -\log_{10} [\text{H}^+]$$

$$= -\log_{10} [12.1 \text{ M}]$$

$$\therefore \text{pH} = -1.08279$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$[\text{OH}^-] = \frac{1 \times 10^{-14}}{[12.1 \text{ M}]}$$

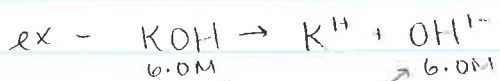
$$\therefore [\text{OH}^-] = 8.26 \times 10^{-16} \text{ M}$$

$$\text{pOH} = -\log_{10} [\text{OH}^-]$$

$$= -\log_{10} [8.26 \times 10^{-16}]$$

$$\therefore \text{pOH} = 15.08279$$





- must do one of the starting points stoichiometrically.

$$\therefore [\text{OH}^{1-}] = 6.0\text{M}$$

$$[\text{H}^+] = \frac{K_w}{[\text{OH}^{1-}]} = \frac{1 \times 10^{-14}}{6.0}$$

$$\therefore [\text{H}^+] = 1.66 \times 10^{-15} \text{ M}$$

$$\text{pH} = -\log_{10} [\text{H}^+] = -\log_{10} [1.66 \times 10^{-15}]$$

$$\therefore \text{pH} = 14.778$$

$$\text{pOH} = 14 - \text{pH}$$

$$= 14 - 14.778$$

$$\therefore \text{pOH} = -0.778$$

* once you know one, you're off to the races!

Do @ Problem #1

pH, pOH, [H⁺], [OH⁻] problems

Jan 21st

1. a) $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$
 $1.0\text{M} \rightarrow 1.0\text{M}$
 $[\text{OH}^-] = \frac{K_w}{[\text{H}^+]}$
 $= \frac{1.0 \times 10^{-14}}{1\text{M}}$
 $\therefore [\text{H}^+] = 1.0\text{M} \checkmark$
 $\therefore [\text{OH}^-] = 1.0 \times 10^{-14}\text{M} \checkmark$
 $\text{pH} = -\log_{10}[\text{H}^+]$
 $= -\log_{10}[1.0\text{M}]$
 $\therefore \text{pH} = 0 \checkmark$
 $\text{pOH} = 14 - \text{pH}$
 $= 14 - 0$
 $\therefore \text{pOH} = 14 \checkmark$

b) $\text{HNO}_3 \rightarrow \text{H}^+ + \text{NO}_3^-$
 $0.50\text{M} \rightarrow 0.50\text{M}$
 $\text{pH} = -\log_{10}[\text{H}^+]$
 $= -\log_{10}[0.50\text{M}]$
 $\therefore [\text{H}^+] = 0.50\text{M} \checkmark$
 $\therefore \text{pH} = 0.301 \checkmark$
 $[\text{OH}^-] = \frac{K_w}{[\text{H}^+]}$
 $= \frac{1.0 \times 10^{-14}}{0.50\text{M}}$
 $\therefore [\text{OH}^-] = 2 \times 10^{-14}\text{M} \checkmark$
 $\text{pOH} = 14 - \text{pH}$
 $= 14 - 0.301$
 $\therefore \text{pOH} = 13.699 \checkmark$

c) $\text{HClO}_4 \rightarrow \text{H}^+ + \text{ClO}_4^-$
 $0.002\text{M} \rightarrow 0.002\text{M}$
 $\text{pH} = -\log_{10}[\text{H}^+]$
 $= -\log_{10}[0.0020]$
 $\therefore [\text{H}^+] = 0.0020\text{M} \checkmark$
 $\therefore \text{pH} = 2.699$
 $[\text{OH}^-] = \frac{K_w}{[\text{H}^+]}$
 $= \frac{1.0 \times 10^{-14}}{0.0020}$
 $\therefore [\text{OH}^-] = 5.0 \times 10^{-12}\text{M}$
 $\text{pOH} = 14 - \text{pH}$
 $= 14 - 2.699$
 $\therefore \text{pOH} = 11.301$

d) $\text{KOH} \rightarrow \text{K}^+ + \text{OH}^-$
 $1.5 \times 10^{-4}\text{M} \rightarrow 1.5 \times 10^{-4}\text{M}$
 $\text{pOH} = -\log_{10}[\text{OH}^-]$
 $= -\log_{10}[1.5 \times 10^{-4}]$
 $\therefore [\text{OH}^-] = 1.5 \times 10^{-4}\text{M} \checkmark$
 $\therefore \text{pOH} = 3.824 \checkmark$
 $[\text{H}^+] = \frac{K_w}{[\text{OH}^-]}$
 $= \frac{1.0 \times 10^{-14}}{1.5 \times 10^{-4}}$
 $\therefore [\text{H}^+] = 6.66 \times 10^{-11}\text{M}$
 $\text{pH} = 14 - \text{pOH}$
 $= 14 - 3.824$
 $\therefore \text{pH} = 10.176 \checkmark$

f) $C_1V_1 = C_2V_2$
 $C_2 = \frac{(0.001\text{L})(0.20\text{M})}{5.0\text{L}}$
 $C_2 = 4.0 \times 10^{-5}\text{M} \checkmark$
 $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$
 $\therefore [\text{H}^+] = 4.0 \times 10^{-5}\text{M}$
 $\text{pH} = -\log_{10}[\text{H}^+]$
 $= -\log_{10}[4.0 \times 10^{-5}]$
 $\therefore \text{pH} = 4.398$
 $[\text{OH}^-] = \frac{K_w}{[\text{H}^+]}$
 $= \frac{1.0 \times 10^{-14}}{4.0 \times 10^{-5}\text{M}}$
 $\therefore [\text{OH}^-] = 2.5 \times 10^{-10}\text{M}$
 $\text{pOH} = 14 - \text{pH}$
 $= 14 - 4.398$
 $\therefore \text{pOH} = 9.602$

e) $C = \frac{n}{V}$
 $= \frac{(0.040\text{g}) \times \frac{1\text{mol}}{40.01\text{g}}}{2.0\text{L}}$
 $C = 4.999 \times 10^{-4}\text{M}$
 $\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-$
 $\therefore [\text{OH}^-] = 5.0 \times 10^{-4}\text{M}$
 $\text{pOH} = -\log_{10}[\text{OH}^-]$
 $= -\log_{10}[5.0 \times 10^{-4}]$
 $\therefore \text{pOH} = 3.30$
 $\text{pH} = 14 - \text{pOH}$
 $= 14 - 3.30$
 $\therefore \text{pH} = 10.7$
 $[\text{H}^+] = \frac{K_w}{[\text{OH}^-]}$
 $= \frac{1.0 \times 10^{-14}}{(5.0 \times 10^{-4})}$
 $\therefore [\text{H}^+] = 2.0 \times 10^{-11}\text{M}$

* g) $\frac{0.10\text{mol Na}_2\text{O}}{1.0\text{L}} \times \frac{2\text{mol NaOH}}{1\text{mol Na}_2\text{O}} \times \frac{1\text{mol OH}^-}{1\text{mol NaOH}}$
 $= 0.20\text{mol OH}^-/\text{L}$
 $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$
 $\therefore [\text{OH}^-] = 0.20\text{M} \checkmark$
 $\text{pOH} = -\log_{10}[\text{OH}^-]$
 $= -\log_{10}[0.20\text{M}]$
 $\therefore \text{pOH} = 0.699$
 $\text{pH} = 14 - \text{pOH}$
 $= 14 - 0.699$
 $\therefore \text{pH} = 13.301$
 $[\text{H}^+] = \frac{K_w}{[\text{OH}^-]}$
 $= \frac{1.0 \times 10^{-14}}{0.20\text{M}}$
 $\therefore [\text{H}^+] = 5 \times 10^{-14}\text{M}$