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(18) (a) $pH = -\log[H^+] = -\log(1\times10^{-13}) = 13$; basic

(b) $k_w = [H^+][OH^-]$

$1\times10^{-14} = [H^+](1\times10^{-7})$

$[H^+] = 1\times10^{-7}$

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

(c) $k_w = [H^+][OH^-]$

$1\times10^{-14} = [H^+](1\times10^{-3})$

$[H^+] = 1\times10^{-11}$

$[H^+] < [OH^-]$; basic

(19) (a) $pH = -\log[H^+] = -\log(1\times10^{-2}) = 2$

(b) $pH = -\log[H^+] = -\log(3.0\times10^{-6}) = 5.5$

(c) $pH + pOH = 14$

$pH + 5.09 = 14$

$pH = 8.91$

$pOH = -\log[OH^-]$

$= -\log(8.2\times10^{-6}) = 5.09$

(20) (a) $pOH = -\log[OH^-] = -\log(1\times10^{-6}) = 6$

$pH + pOH = 14$

$pH = 8$

(b) $pOH = -\log[OH^-] = -\log(6.5\times10^{-4}) = 3.19$

$pH + pOH = 14$

$pH = 10.81$

(c) $pH = -\log[H^+] = -\log(3.6\times10^{-9}) = 8.44$

$pH + pOH = 14$

$pOH = 5.56$

20 (d) $pH = -\log[H^+] = -\log(0.025) = \underline{1.6}$

$pH + pOH = 14$

$\underline{pOH = 12.4}$

(21) (a) $pH = -\log[H^+]$

$-2.37 = +\log[H^+]$

$\underline{[H^+] = 0.0043 \text{ mol/L}}$

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

$1 \times 10^{-14} = (0.0043)[OH^-]$

$\underline{[OH^-] = 2.33 \times 10^{-12} \text{ mol/L}}$

(b) $pH = -\log[H^+]$

$-11.05 = +\log[H^+]$

$\underline{[H^+] = 8.91 \times 10^{-12} \text{ mol/L}}$

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

$1 \times 10^{-14} = (8.91 \times 10^{-12})[OH^-]$

$\underline{[OH^-] = 0.0011 \text{ mol/L}}$

(c) $pH = -\log[H^+]$

$-6.50 = +\log[H^+]$

$\underline{[H^+] = 3.16 \times 10^{-7} \text{ mol/L}}$

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

$1 \times 10^{-14} = (3.16 \times 10^{-7})[OH^-]$

$\underline{[OH^-] = 3.16 \times 10^{-8} \text{ mol/L}}$

(23) (a) $pH = -\log[H^+]$

$= -\log(1)$

$\underline{pH = 0}$

(b) $pH = -\log[H^+]$

$= -\log(0.05)$

$\underline{pH = 1.3}$

(c) $pOH = -\log[OH^-]$

$= -\log(1)$

$pOH = 0$

$pH + pOH = 14$

$pH + 0 = 14$

$\underline{pH = 14}$

(d) $pOH = -\log[OH^-]$

$= -\log(2.4 \times 10^{-5})$

$pOH = 4.62$

$pH + pOH = 14$

$pH + 4.62 = 14$

$\underline{pH = 9.38}$