Acid-Base Quiz 2019 Name:_____ /15

1. What is the pH of a solution whose:

a. $[H^+] = 2.1 \times 10^{-3}$M 2.7

b. $[OH^-] = 3.8 \times 10^{-5}$M 9.6

c. pOH is 6.8 7.2

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

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

$pH + pOH = 14$

Show work

2. Determine the pH of a solution made by mixing 0.25 g of NaOH in 500 mL of water?(4)
NaOH is a very strong base that dissociates at nearly 100%

$\frac{1 mol NaOH}{x} = \frac{40.00g}{0.25g}$

$x = 6.25 \times 10^{-3}$ mol

$\frac{6.25 \times 10^{-3} mol}{0.500L} = 0.0125M$

$NaOH \rightarrow Na^+ + OH^-$

$pOH = -\log[OH^-]$
$= -\log[0.0125]$
$pOH = 1.90$

$pH + pOH = 14$
$14 - pOH = pH$
$14 - 1.90 = pH$
$\boxed{12.1 = pH}$

3. What is the pH of a 0.400 M ammonia solution? (4)

$NH_{3\,(aq)} + H_2O_{(l)} \rightleftarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ $K_b = 1.8 \times 10^{-5}$

NH_3	NH_4^+	OH^-
0.400	0	0
$-x$	$+x$	$+x$
$0.400 - x$	x	x

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

$1.8 \times 10^{-5} = \frac{x^2}{0.400 - \cancel{x}}$

$7.2 \times 10^{-6} = x^2$

$2.68 \times 10^{-3} = x = [OH^-]$

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

$10^{-14} = [H^+](2.68 \times 10^{-3})$

$[H^+] = 3.73 \times 10^{-12}$

$pH = -\log[H^+]$
$= -\log 3.73 \times 10^{-12}$
$= 11.4$

$\boxed{pH = 11}$

4. Calculate the % ionization of a 0.60 M solution of HSO_4^-. (4)

$HSO_4^-{}_{(aq)} \rightleftarrows H^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$ $K_a = 1.2 \times 10^{-2}$

0.60	0	0
$-x$	$+x$	$+x$
$0.60 - x$	x	x

$K_a = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]}$

$1.2 \times 10^{-2} = \frac{x^2}{0.60 - x}$

$0.0072 - 0.012x = x^2$

$0 = x^2 + 0.012x - 0.0072$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{-0.012 \pm \sqrt{0.012^2 - 4(1)(-0.007}}{2(1)}$

$= \frac{-0.012 \pm \sqrt{0.0028944}}{2}$

$x = 0.0791$

$x = \cancel{-0.0911}$

$\% = \frac{[H^+]}{[HSO_4^-]} \times 100$

$= \frac{0.0791}{0.60} \times 100$

$= 13\%$

Acid-Base Quiz 2019 v2 Name:_____

Show all your work for questions 2, 3 and 4.

1. What is the pH of a solution whose:

   a. $[H^+] = 2.7 \times 10^{-3}M$ 2.6

   b. $[OH^-] = 8.8 \times 10^{-5}M$ 9.9 pOH = 4.06

   c. pOH is 3.8 10.

2. Determine the pH of a solution made by mixing 0.25 g of NaOH in 750 mL of water?(4) NaOH is a very strong base that dissociates at nearly 100%

$$\frac{1\ mol\ NaOH}{x} = \frac{40.00g}{0.25g}$$

$$x = 6.25 \times 10^{-3} mol$$

$$\frac{6.25 \times 10^{-3} mol}{0.750 L} = 8.\bar{3} \times 10^{-3} M = [OH^-]$$

$$pOH = -\log[OH^-]$$
$$= -\log(8.\bar{3} \times 10^{-3})$$
$$pOH = 2.08$$

$$pH + pOH = 14$$
$$pH = 14 - pOH$$
$$= 14 - 2.08$$

$\boxed{pH = 11.9}$ $\boxed{pH = 12}$

3. What is the pH of a 0.450 M ammonia solution? (4)

$NH_{3\,(aq)} + H_2O_{(l)} \rightleftarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ $K_b = 1.8 \times 10^{-5}$

NH_3	NH_4^+	OH^-
0.450	0	0
-x	+x	+x
0.450	x	x

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

$$1.8 \times 10^{-5} = \frac{x^2}{0.450 - \cancel{x}}$$

$$\sqrt{8.1 \times 10^{-6}} = \sqrt{x^2}$$

$$2.845 \times 10^{-3} = x = [OH^-]$$

$$pOH = -\log(2.845 \times 10^{-3}) = 2.5458$$

$$pH = 14 - pOH$$
$$= 14 - 2.5458$$
$$= 11.454$$

$\boxed{pH = 11}$

4. Calculate the % ionization of a 0.50 M solution of HSO_4^-. (4)

$HSO_4^-{}_{(aq)} \rightleftarrows H^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$ $K_a = 1.2 \times 10^{-2}$

HSO_4^-	H^+	SO_4^{2-}
0.50	0	0
-x	+x	+x
0.50-x	x	x

$$K_a = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]}$$

$$1.2 \times 10^{-2} = \frac{x^2}{0.50 - x}$$

$$6 \times 10^{-3} - 0.012x = x^2$$

$$0 = x^2 + 0.012x - 0.006$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-0.012 \pm \sqrt{(0.012)^2 - 4(1)(-0.006)}}{2(1)}$$

$$= \frac{-0.012 \pm \sqrt{0.024144}}{2}$$

$x = 0.0717$ or $x = -0.0837$

$$\%\ ionization = \frac{[H^+]}{[HSO_4^-]} \times 100$$

$$= \frac{0.0717}{0.50} \times 100$$

$$= 14\%$$

Acid-Base Quiz 2019 v3 Name: Answers

Show all your work for questions 2, 3 and 4.

1. What is the pH of a solution whose:

   a. $[H^+] = 7.2 \times 10^{-3}$M 2.1

   b. $[OH^-] = 1.8 \times 10^{-5}$M 9.3

   c. pOH is 13.8 0.2

2. Determine the pH of a solution made by mixing 0.25 g of NaOH in 900 mL of water?(4)
   NaOH is a very strong base that dissociates at nearly 100%

$\frac{1 \text{ mol NaOH}}{x} = \frac{40.00 g}{0.25 g}$

$x = 6.25 \times 10^{-3}$ mol

$\frac{6.25 \times 10^{-3} \text{ mol}}{0.900 L} = 6.94 \times 10^{-3} M = [OH]$

$pOH = -\log(6.94 \times 10^{-3})$
$= 2.16$

$pH = 14 - pOH$
$= 14 - 2.16$
$= 11.8.$

$\boxed{pH = 12}$

3. What is the pH of a 0.600 M ammonia solution? (4)

$NH_{3\,(aq)} + H_2O_{(l)} \rightleftarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ $K_b = 1.8 \times 10^{-5}$

NH_3	NH_4^+	OH^-
0.600	0	0
$-x$	$+x$	$+x$
$0.600-x$	x	x

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

$1.8 \times 10^{-5} = \frac{x^2}{0.600 - \cancel{x}}$

$\sqrt{1.08 \times 10^{-5}} = \sqrt{x^2}$

$3.29 \times 10^{-3} = x = [OH^-]$

$pOH = -\log(3.29 \times 10^{-3})$
$= 2.48$

$pH = 14 - pOH$
$= 14 - 2.48$
$= 11.5$

$\boxed{pH = 12}$

4. Calculate the % ionization of a 0.70 M solution of HSO_4^-. (4)

$HSO_4^-{}_{(aq)} \rightleftarrows H^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$ $K_a = 1.2 \times 10^{-2}$

HSO_4^-	H^+	SO_4^{2-}
0.70	0	0
$-x$	$+x$	$+x$
$0.70-x$	x	x

$K_a = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]}$

$1.2 \times 10^{-2} = \frac{x^2}{0.70 - x}$

$8.4 \times 10^{-3} - 1.2 \times 10^{-2} x = x^2$

$0 = x^2 + 0.012x - 0.0084$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{-0.012 \pm \sqrt{0.012^2 - 4(1)(-0.0}}{2(1)}$

$= \frac{-0.012 \pm \sqrt{0.033601}}{2}$

$x = 0.08565$
or
$x = -0.09785.$

% ionization $= \frac{[H^+]}{[HSO_4^-]} \times 100$

$= \frac{0.08565}{0.7} \times 100 = 12\%$