Acids + Bases Review

(1) B

(2) A

(3) $HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$

	HNO_2	H_3O^+	NO_2^-
I	.1	0	0
C	$-x$	$+x$	$+x$
E	$.1-x$	x	x

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]}$$

$$5.1 \times 10^{-4} = \frac{(x)(x)}{.1}$$

$$[H_3O^+] = 0.0071 \text{ mol/L}$$

(4) strong acid, so $[H^+] = 0.015$ mol/L

$$pH = -\log[H^+]$$
$$= -\log(0.015)$$
$$pH = 1.8$$

(5) $\frac{[H_3O^+]}{\text{initial}} \times 100 = \frac{5.0 \times 10^{-3}}{0.16} \times 100 = 3.1\%$

(6) A

(7) D

(8) $HBr + KOH \rightarrow H_2O + KBr$

$[KOH] = \frac{mol}{L}$

$.1 = \frac{x}{.04}$

$x = 0.004$ mol of KOH

∴ we need 0.004 mol of HBr

$[HBr] = \frac{mol}{L} = \frac{.004}{.02} = \underline{0.2 \text{ mol/L}}$

(9) strong base, so $[OH^-] = 0.2$ mol/L

$k_w = [H_3O^+][OH^-]$

$1 \times 10^{-14} = [H_3O^+](0.2)$

$\underline{[H_3O^+] = 5 \times 10^{-14} \text{ mol/L}}$

(10) B

(11) C

(12) $HBrO_3 + H_2O \rightleftharpoons BrO_3^- + H_3O^+$

$pH = -\log[H_3O^+]$

$-3.56 = -\log[H_3O^+]$

$[H_3O^+] = 2.75 \times 10^{-4}$ mol/L

	$HBrO_3$	BrO_3^-	H_3O^+
I	0.1	0	0
C	-2.75×10^{-4}	$+2.75\times10^{-4}$	$+2.75\times10^{-4}$
E	0.0997	2.75×10^{-4}	2.75×10^{-4}

$k_a = \frac{[H_3O^+][BrO_3^-]}{[HBrO_3]} = \frac{(2.75\times10^{-4})(2.75\times10^{-4})}{(0.0997)} = \underline{7.59 \times 10^{-7}}$

(13) $NaHCO_3 \xrightarrow{H_2O} Na^+ + HCO_3^-$

$Na^+ + H_2O \rightarrow$ no reaction, from strong base

$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$ (we are told that it is a basic salt)

$(K_a)(K_b) = K_w$

$(4.4 \times 10^{-7})\, K_b = 1 \times 10^{-14}$

$K_b = 2.27 \times 10^{-8}$ for HCO_3^-

$$K_b = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$$

	HCO_3^-	H_2CO_3	OH^-
I	.25	0	0
C	$-x$	$+x$	$+x$
E	$.25-x$	x	x

$$2.27 \times 10^{-8} = \frac{x^2}{.25}$$

$[OH^-] = 7.53 \times 10^{-5}$

$K_w = [H_3O^+][OH^-]$

$1 \times 10^{-14} = [H_3O^+](7.53 \times 10^{-5})$

$[H_3O^+] = 1.33 \times 10^{-10}$

$pH = -\log[H_3O^+]$

$= -\log(1.33 \times 10^{-10})$

$pH = 9.88$

(14) (a) strong (b) weak (c) weak (d) strong
(e) strong (f) strong (g) weak

(15) cecetic acid CH_3COOH

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

$$k_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$$

(16) (a) $HClO_4 + H_2O \rightarrow H_3O^+ + ClO_4^-$
0.01 mol/L .01 mol/L

$$pH = -\log[H_3O^+] = -\log(.01) = \underline{2}$$

(b) $NaOH \rightarrow Na^+ + OH^-$
.1 .1

$$pOH = -\log[OH^-] = -\log(.01) = 2$$

$$pH + pOH = 14$$

$$pH = \underline{12}$$

(c) $\underline{pH = 7}$

(17) $KF \rightarrow K^+ + F^-$

$K^+ + H_2O \rightarrow$ no reaction (K^+ is from a strong base)

$F^- + H_2O \rightarrow HF + OH^-$

$$k_b = \frac{[HF][OH^-]}{[F]^-}$$

$$k_w = (k_a)(k_b)$$

$$k_b = \frac{k_w}{k_a} = \frac{1 \times 10^{-14}}{6.7 \times 10^{-4}} = 1.49 \times 10^{-11}$$

	F^-	HF	OH^-
I	.5	0	0
C	$-x$	$+x$	$+x$
E	$.5 - \cancel{x}$	x	x

↑ not significant

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17 cont'd

$$1.49\times10^{-11} = \frac{(x)(x)}{.5}$$

$$x = 2.73\times10^{-6} \text{ mol/L}$$

$$pOH = -\log[OH^-] = -\log(2.73\times10^{-6}) = 5.56$$

$$pH + pOH = 14$$

$$pH = 14 - pOH = 14 - 5.56 = \underline{8.44}$$

(18) $HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$

	HNO_2	H_3O^+	NO_2^-
I	0.0150	0	0
C	$-x$	$+x$	$+x$
E	$0.015-x$	x	x

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]}$$

$$4.5\times10^{-4} = \frac{(x)(x)}{.015}$$

$$x = 0.0026$$

$$pH = -\log[H_3O^+]$$

$$= -\log(0.0026)$$

$$\underline{pH = 2.59}$$

(19) $pOH = -\log[OH^-] = -\log(2) = -0.301$

$pH + pOH = 14$

$pH = \underline{14.3}$ $\underline{\text{basic}}$

(20) $pH = -\log(1) = 0$

$pH + pOH = 14$

$pOH = 14$

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

$-14 = +\log[OH^-]$

$\underline{[OH^-] = 1\times10^{-14} \text{ mol/L}}$