Name Beth "Key" Period ______
Review Worksheet
Acids/Bases

1. Write molecular, complete ionic and net ionic equations for the following neutralization reactions.
a. Aqueous phosphoric acid (H_3PO_4) reacts with aqueous calcium hydroxide.

$2H_3PO_{4(aq)} + 3Ca(OH)_{2(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6H_2O_{(l)}$

$6H^+_{(aq)} + 2PO_4^{3-}{}_{(aq)} + 3Ca^{2+}_{(aq)} + 6OH^-_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6H_2O_{(l)}$

Net will be the same as complete ionic since the salt is insoluble and will precipitate out.

What is the final pH for this reaction? 7

b. Aqueous sulfuric acid reacts with aqueous potassium hydroxide.

$H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$

$2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2K^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2K^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2H_2O_{(l)}$

$2H^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$

What is the final pH for this reaction? 7

2. Write equations to show the dissociation/ionization for the following in aqueous solution.

a. HCl (strong acid) $HCl \xrightarrow{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$

b. $HC_2H_3O_2$ (weak acid) $HC_2H_3O_2 \xleftrightarrow{H_2O} H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$

c. KOH (strong base) $KOH \xrightarrow{H_2O} K^+_{(aq)} + OH^-_{(aq)}$

d. NH_3(weak base) Look at your PPT slides for help! $NH_3 + H_2O \leftrightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$

3. Complete the following table.

Acid	Base	Conjugate Acid	Conjugate Base	Equation
HNO_2	H_2O	H_3O^+	NO_2^-	$HNO_2 + H_2O \rightarrow NO_2^- + H_3O^+$
H_2O	F^-	HF	OH^-	$H_2O + F^- \rightarrow HF + OH^-$
HCN	NH_3	NH_4^+	CN^-	$NH_3 + HCN \rightarrow NH_4^+ + CN^-$
$HClO_3$	OH^-	H_2O	ClO_3^-	$HClO_3 + OH^- \rightarrow H_2O + ClO_3^-$
HSO_4^-	PO_4^{3-}	HPO_4^{2-}	SO_4^{2-}	$HSO_4^- + PO_4^{3-} \rightarrow HPO_4^{2-} + SO_4^{2-}$
H_2O	S^{2-}	HS^-	OH^-	$S^{2-} + H_2O \rightarrow OH^- + HS^-$
HCO_2H	OH^-	H_2O	CO_2H^-	$HCO_2H + OH^- \rightarrow H_2O + CO_2H^-$

4. Calculate the pH for the following and indicate if the solution is acidic, basic or neutral.
   a. 0.25M HCl
   pH = 0.60
   ACID
   b. 1.45×10^{-3}M H_2SO_4
   x 2
   pH = 2.538
   ACID
   c. 3.6×10^{-2}M NaOH
   pOH = 1.44
   pH = 12.56
   BASE
   d. 8.334×10^{-4} HNO_3
   pH = 3.0791
   ACID

5. What is the pH of a solution made by diluting 25 mL of 6.0 M HCl until the final volume of the solution is 1.75 L?

$M = \frac{mol}{L}$ $L \cdot M = mol$

$$.025L \cdot 6.0M = \frac{0.15\,mol}{1.75L} = \boxed{0.086M}$$

6. What is the $[H^+]$ for the following:
   a. An HCl solution with a pH of 3.45?

$$[H^+] = 10^{-pH} \quad 10^{-3.45} = 3.5 \times 10^{-4} M\ H^+$$

   b. A NaOH solution with a pH of 8.97?

$$10^{-8.97} = 1.1 \times 10^{-9} M\ H^+$$

   c. An HNO_3 solution with a pH of 6.323?

$$10^{-6.323} = 4.75 \times 10^{-7}\ H^+$$

7. An acidic solution has a pH of 4. If I dilute 10 mL of this solution to a final volume of 1000 mL, what is the pH of the resulting solution?

$$[H^+] = 10^{-4} = 1 \times 10^{-4} M$$

$M = \frac{mol}{L}$

$M \cdot L = mol$

$(.010L)(1 \cdot 10^{-4}M) = 1 \times 10^{-6} mol$

$$\frac{1 \times 10^{-6} mol}{1.000L\ (1000mL)} = 1 \times 10^{-6} M$$

8. You titrate a 35.0 mL sample of HCL with 0.10 M $Mg(OH)_2$. The titration requires 23.8 mL of the base. Calculate the concentration of the HCl solution.

$M_aV_a = M_bV_b$ $M_a = \frac{M_bV_b}{V_a}$

$0.10M\ Mg(OH)_2 = 0.20M\ OH^-$

$$M_a = \frac{(0.20M\ OH^-)(23.8mL\ OH^-)}{(35.0mL\ H^+)} = \boxed{0.14M\ HCl}$$

9. You titrate 25.50 ml of 0.35M H_2SO_4 with 18.60 mL of NaOH. What is the concentration of the NaOH?

$M_b = \frac{M_aV_a}{V_b}$ $M_a = 0.35M\ H_2SO_4 \times \frac{2H^+}{1\ H_2SO_4} = 0.70M\ H^+$

$$M_b = \frac{(0.70M\ H^+)(25.50mL)}{18.60mL} = \boxed{0.96M\ NaOH}$$

10. What is meant when an acid is described as strong or weak?

Strong indicates molecules of acid will all ionize to form H+ and an anion.

Weak means that only a few of the acid molecules will ionize to form H+ and an anion.

1) $HC_7H_3O_{2(aq)} \leftrightarrows H^+_{(aq)} + C_7H_3O_2^-{}_{(aq)}$

	$HC_7H_3O_{2(aq)}$	$H^+_{(aq)}$	$C_7H_3O_2^-{}_{(aq)}$
initial	0.35 M	0 M	0 M
change	- x M	+ x M	+x M
equilibrium	(0.35 – x) M	x M	x M

Note that: (0.35 – x) M ≈ 0.35 M so

$$K_a = \frac{[H^+][C_7H_3O_2^-]}{[HC_7H_3O_2]} = \frac{(x)(x)}{(0.35 - x)} = \frac{(x)(x)}{(0.35)} = \frac{x^2}{(0.35)} = 6.3 \times 10^{-5}$$

$x^2 = (6.3 \times 10^{-5})(0.35) = 2.205 \times 10^{-5}$

$x = 4.7 \times 10^{-3}$ M x = moles/L formed

$pH = -\log(4.7 \times 10^{-3}) = 2.33$

2) $HClO_{(aq)} \leftrightarrows H^+_{(aq)} + ClO^-_{(aq)}$

	$HClO_{(aq)}$	$H^+_{(aq)}$	$ClO^-_{(aq)}$
initial	0.275 M	0 M	0 M
change	- x M	+ x M	+x M
equilibrium	(0.275 – x) M	x M	x M

Note that: (0.275 – x) M ≈ 0.275 M so

$$K_a = \frac{[H^+][ClO^-]}{[HClO]} = \frac{(x)(x)}{(0.275 - x)} = \frac{(x)(x)}{(0.275)} = \frac{x^2}{(0.275)} = 3.0 \times 10^{-8}$$

$x^2 = (3.0 \times 10^{-8})(0.275) = 8.25 \times 10^{-9}$

$x = 9.08 \times 10^{-5}$ M

$pH = -\log(9.08 \times 10^{-5}) = 4.042$

3) First the amount of H^+ from each acid must be calculated.

$HNO_{2(aq)} \leftrightarrows H^+_{(aq)} + NO_2^-{}_{(aq)}$

	$HNO_{2(aq)}$	$H^+_{(aq)}$	$NO_2^-{}_{(aq)}$
initial	0.0925 M	0 M	0 M
change	- x M	+ x M	+x M
equilibrium	(0.0925 – x) M	x M	x M

Note that: (0.0925 – x) M ≈ 0.0925 M so

$$K_a = \frac{[H^+][NO_2^-]}{[HNO_2]} = \frac{(x)(x)}{(0.0925 - x)} = \frac{(x)(x)}{(0.0925)} = \frac{x^2}{(0.0925)} = 4.5 \times 10^{-4}$$

$x^2 = (4.5 \times 10^{-4})(0.0925) = 4.1625 \times 10^{-5}$

$x = 6.45 \times 10^{-3}$ M x = moles/L formed

$HC_2H_3O_{2(aq)} \leftrightarrows H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$

	$HC_2H_3O_{2(aq)}$	$H^+_{(aq)}$	$C_2H_3O_2^-{}_{(aq)}$
initial	0.139 M	0 M	0 M
change	- x M	+ x M	+x M
equilibrium	(0.139 – x) M	x M	x M

Note that: (0.139 – x) M ≈ 0.139 M so

$$K_a = \frac{[H^+][C_2H_3O_2^-]}{[H\,C_2H_3O_2]} = \frac{(x)(x)}{(0.139 - x)} = \frac{(x)(x)}{(0.139)} = \frac{x^2}{(0.139)} = 1.8 \times 10^{-5}$$

$x^2 = (1.8 \times 10^{-5})(0.139) = 2.502 \times 10^{-6}$

$x = 1.58 \times 10^{-3}$ M

Then add the results together and use that value to find the pH.

6.45×10^{-3} M + 1.58×10^{-3} M = 8.03×10^{-3} M

$pH = -\log(8.03 \times 10^{-3}) = 2.095$