Acid Base III Worksheet 2

1. $HIn + H_2O \rightleftharpoons In^- + H_3O^+$

(a) yellow in acid solution - eq= shifts left - HIn is predominant form

(b) blue in base solution - eq= shifts right - In^- is predominant form

(c) in solutions with high $[H_3O^+]$ yellow HIn is in greater concentration. As $[H_3O^+]$ decreased solution reached a point where $[HIn] = [In^-]$ at this point the amount of yellow and blue is equal and green colour is observed. As $[H_3O^+]$ decreases further the blue In^- is the predominant form and the solution is blue.

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2. $HA + KOH \longrightarrow H_2O + KA$

(a) mol KOH = 18.4 mL × 0.100 M = 1.84 mmol

ratio is 1:1 so mol HA = 1.84 mmol

$[HA] = \frac{1.84 \text{ mmol}}{10.0 \text{ mL}} = 0.184 \text{ M}$

(b) $0.220 \text{ g} \div 1.84 \text{ mmol} = 120 \text{ g/mole}$

(c) pH at stoichiometric endpoint is 9.600 ∴ acid is weak.

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3. mol $Ba(OH)_2$ = 50.0 mL × 0.0200 M = 1.00 mmol $Ba(OH)_2$

mol OH^- = 2 × 1.00 mmol = 2.00 mmol OH^-

mol H^+ = 30.0 mL × 0.0100 M = 0.300 mmol H^+

mol OH^- in excess = 2.00 - 0.300 = 1.70 mmol

$[OH^-] = \frac{1.70 \text{ mmol}}{(50.0 + 30.0) \text{ mL}} = 0.0213 \text{ M}$ pOH = 1.673 pH = 12.327

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4. $[HCl] = 10^{-2.63} = 2.34 \times 10^{-3} \text{ M}$

$[NaOH] = 10^{-(14-10.82)} = 6.61 \times 10^{-4} \text{ M}$

mol H^+ = 2.34×10^{-3} M × 30.0 mL = 7.02×10^{-2} mmol

mol OH^- = 6.61×10^{-4} M × 70.0 mL = 4.63×10^{-2} mmol

mol H^+ in excess = $7.02 \times 10^{-2} - 4.63 \times 10^{-2} = 2.39 \times 10^{-2}$ mmol

$[H^+] = \frac{2.39 \times 10^{-2} \text{ mmol}}{(30.0 + 70.0) \text{ mL}} = 2.39 \times 10^{-4} \text{ M}$ pH = 3.62

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5. $NH_4NO_3 \longrightarrow NH_4^+ + NO_3^-$ NO_3^- does not hydrolyze.

R	$NH_4^+ + H_2O \longleftrightarrow$	NH_3	$+ H_3O^+$
I	1.00	0	0
C	$-x$	$+x$	$+x$
E	$1.00 - x \approx 1.00$ if x is small		

$$[NH_4^+]_{initial} = \frac{2.0g \div 80.0 g/mol}{0.0250 L} = 1.00 M$$

$$Ka = \frac{[NH\ \ ][H_3O^+]}{[NH_4^+]} = 5.6 \times 10^{-10} = \frac{x^2}{1.00}$$

$x = [H_3O^+] = 2.37 \times 10^{-5} M$ $pH = -\log(2.37 \times 10^{-5} M) = 4.62$

6.

R	$NH_3 + H_2O \longleftrightarrow$	NH_4^+	$+ OH^-$
I	2.0M	0	0
C	$-x$	$+x$	$+x$
E	$2.0M - x \approx 2.0M$ if x is small	x	x

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

$$K_b = \frac{x^2}{2.0} = 1.79 \times 10^{-5} \quad [OH^-] = x = 5.98 \times 10^{-3} M$$

$pOH = -\log(5.98 \times 10^{-3}) = 2.224$

$pH = pKw - pOH = 14.00 - 2.224 = 11.78$

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7. Several answers apply:
eg. titration
pH at endpoint of titration

8. $HA + NaOH \rightarrow NaA + H_2O$

(a) mol OH^- = 0.10M × 20.0 mL = 2.00 mmol

mol HA = mol OH^- = 2.00 mmol

$$[HA] = \frac{2.00\ mmol}{10.0\ mL} = 0.20\ M$$

(b) pH at midpoint = 5.67 = pK_a

$K_a = 10^{-5.67} = 2.1 \times 10^{-6}$