Chemistry 12
Worksheet 4-7—Indicators

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Name KEY

Due Date _____

Correct & Hand In by _____

This worksheet covers material from class notes and Student Workbook pages 159-163

1. An indicator HInd is yellow in 0.1M NaOH and blue in 0.1M HCl. The pH range in which the colour change occurs in this indicator is 3.6 - 5.2.

a) Write the ***equilibrium equation*** describing this indicator.(1)

$\underset{\text{blue}}{HInd} + H_2O \rightleftharpoons H_3O^+ + \underset{\text{yellow}}{Ind^-}$

b) What is the colour of HInd? blue What is the colour of Ind^-? yellow (2)

c) What is the pH at the transition point of this indicator? 4.4 (1)

d) What is the value of pKa for this indicator? 4.4 (1)

e) What is the Ka of this indicator? 4×10^{-5} (1)

f) At pH = 2.2, this indicator is the colour blue and [HInd] (>,<,=) > [Ind^-].(2)

g) At pH = 7.0, this indicator is the colour yellow and [HInd] (>,<,=) < [Ind^-].(2)

h) At pH = 11.3, this indicator is the colour yellow and [HInd] (>,<,=) < [Ind^-].(2)

i) At pH = 4.4, this indicator is the colour green and [HInd] (>,<,=) = [Ind^-].(2)

j) At pH = 4.3, this indicator is the colour green and [HInd] (>,<,=) > [Ind^-].(2)

k) In 0.001M HNO_3 (pH = 3), this indicator is the colour blue and [HInd] (>,<,=) > [Ind^-].(2)

l) In 0.001M KOH (pH = 11), this indicator is the colour yellow and [HInd] (>,<,=) < [Ind^-].(2)

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m) At the *transition point*, is [H_3O^+] = Ka (indicator.)? yes (1)

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2. A solution turns yellow when Orange IV is added and red when methyl orange is added. Give the approximate pH range of the solution. (1)

> 2.8 < 3.2

Answer pH = 2.8 - 3.2 (1)

3. A solution turns yellow when chlorophenol red is added and also yellow when methyl orange is added. Give the approximate pH range of the solution. (1)

< 5.2 > 4.4

Answer pH = 4.4 - 5.2 (1)

4. A solution turns magenta when phenolphthalein is added and yellow when alizarin yellow is added. Determine the approximate $[H_3O^+]$. (1)

> 10.0 < 10.1

pH ≈ 10.05 (10)

Answer $[H_3O^+]$ = (1×10^{-10}) (9×10^{-11}) (1)

5. A 0.10 M solution of a weak acid HX turns red in both chlorophenol red and in neutral red indicator.

> 6.8

a) Determine the approximate pH of this solution of HX. 6.8 (1) (1)

$[H_3O^+] = 1.6 \times 10^{-7}$

b) Determine the Ka of the weak acid HX (Not the Ka (indicator)!) (Hint: Use an ICE table!) (2)

$HX + H_2O \rightleftharpoons H_3O^+ + X^-$

0.10		0	0
-1.6×10^{-7}		$+1.6 \times 10^{-7}$	$+1.6 \times 10^{-7}$
≈ 0.10		1.6×10^{-7}	1.6×10^{-7}

$K_a = \frac{[H_3O^+][X^-]}{[HX]} = \frac{(1.6 \times 10^{-7})^2}{0.10} = 3 \times 10^{-13}$ (2)

Answer Ka = 3×10^{-13}

6. An indicator "Gupta Green" (HGg) turns yellow when $[H_3O^+]$ drops below 1.2×10^{-4} M and turns blue when $[H_3O^+]$ rises above 1.8×10^{-3} M. (Notice 2 SD's)

pH > 3.92 pH < 2.74

a) Find the pH range over which the indicator changes colour.(2SD's) (2)

pH Range 2.74 - 3.92 (2)

b) Determine the pKa of the indicator "Gupta Green". (1) 3.33 (1)

pH = 3.72

c) What colour would 0.00019 M HCl be in this indicator? (1) green (1)

d) What colour would 0.010 M NaOH be in this indicator? (1) yellow (1)

pOH = 2.00

pH = 12.00

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e) What colour would 0.10 M CH_3COOH be in this indicator?
(Show how you got $[H_3O^+]$) (2)

$[H_3O^+] = \sqrt{Ca \cdot Ka} = \sqrt{0.10 (1.8 \times 10^{-5})}$

$[H_3O^+] = 1.34 \times 10^{-3}$ M

pH = 2.87

Answer green (2)

7. An indicator ~~HInd turns~~ yellow in 0.10 M HCl and blue in 0.10 M NaOH.

a) Write the equation describing the ***equilibrium*** in HInd. (1)

$HInd_{yellow} + H_2O \rightleftharpoons H_3O^+ + Ind^-_{blue}$ (1)

b) What colour is HInd? (1) yellow What colour is Ind^-? (1) blue (1)

c) HInd is green in the range pH = 5.4 to pH = 6.2. Determine the Ka of HInd.(1)

pka = pH = 5.8

Ka = 2×10^{-6} (1)

d) When a few drops of HInd are added to a weak acid HA_1, the colour is yellow. Which is the stronger acid, HInd or HA_1? (1)

$HA_1 + Ind^- \rightleftharpoons HInd + A_1^-$

SrA WrA (yellow)

Answer HA_1 is the stronger acid. (1)

e) When a few drops of HInd are added to a weak acid HA_2, the colour is blue. Which is the stronger acid, HInd or HA_2? (1)

$HA_2 + Ind^- \rightleftharpoons HInd + A_2^-$

WrA (blue) SrA

Answer HInd is the stronger acid. (1)

f) Which acid is stronger, HA_1, or HA_2? (1) HA_1 (1)

g) List the acids HInd, HA_1 and ~~HA_2 in order of strength~~ from strongest to weakest.(1) $HA_1 > HInd > HA_2$ (1)

h) List the bases Ind^-, A_1^-, and A_2^-, ~~in order of strength~~ from strongest to weakest.(1) $A_2^- > Ind^- > A_1^-$ (1)

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