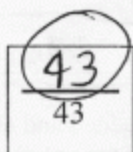


**Chemistry 12**  
**Worksheet 4-7—Indicators**

Name \_\_\_\_\_ KEY

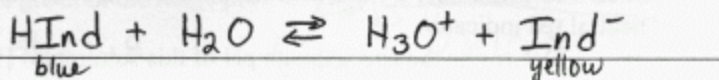
Due Date \_\_\_\_\_

Correct &amp; 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)



b) What is the colour of HInd? blue What is the colour of Ind<sup>-</sup>? 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?  $4 \times 10^{-5}$  (1)

f) At pH = 2.2, this indicator is the colour blue and  $[\text{HInd}]_{(pH=2.2)} > [\text{Ind}^-]_{(pH=2.2)}$  (2)

g) At pH = 7.0, this indicator is the colour yellow and  $[\text{HInd}]_{(pH=7.0)} < [\text{Ind}^-]_{(pH=7.0)}$  (2)

h) At pH = 11.3, this indicator is the colour yellow and  $[\text{HInd}]_{(pH=11.3)} < [\text{Ind}^-]_{(pH=11.3)}$  (2)

i) At pH = 4.4, this indicator is the colour green and  $[\text{HInd}]_{(pH=4.4)} = [\text{Ind}^-]_{(pH=4.4)}$  (2)

j) At pH = 4.3, this indicator is the colour green and  $[\text{HInd}]_{(pH=4.3)} > [\text{Ind}^-]_{(pH=4.3)}$  (2)

k) In 0.001M <sup>pH=3</sup> HNO<sub>3</sub>, this indicator is the colour blue and  $[\text{HInd}]_{(pH=3)} > [\text{Ind}^-]_{(pH=3)}$  (2)

l) In 0.001M <sup>pH=11</sup> KOH, this indicator is the colour yellow and  $[\text{HInd}]_{(pH=11)} < [\text{Ind}^-]_{(pH=11)}$  (2)



m) At the *transition point*, is  $[\text{H}_3\text{O}^+] = K_a$  (indicator.)? yes (1)

KEY

&gt; 2.8 &lt; 3.2

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)

Answer pH = 2.8 - 3.2 (1)

&lt; 5.2

&gt; 4.4

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)

Answer pH = 4.4 - 5.2 (1)

&gt; 10.0

&lt; 10.1

4. A solution turns magenta when phenolphthalein is added and yellow when alizarin yellow is added. Determine the approximate  $[H_3O^+]$  (1)  $pH \approx 10.05$  (10)

Answer  $[H_3O^+] = (1 \times 10^{-10})$  ( $9 \times 10^{-11}$ ) (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  $K_a$  of the weak acid HX (Not the  $K_a$  (indicator)!) (Hint: Use an ICE table!) (2)

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

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

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

Answer  $K_a = 3 \times 10^{-13}$  (2)

6. An indicator "Gupta Green" (HGg) turns yellow when  $[H_3O^+]$  drops below  $1.2 \times 10^{-4}$  M and turns blue when  $[H_3O^+]$  rises above  $1.8 \times 10^{-3}$  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  $pK_a$  of the indicator "Gupta Green". (1) 3.33 (1)

- 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)

 $pOH = 2.00$   
 $pH = 12.00$ 


[KEY]

- e) What colour would 0.10 M CH
- <sub>3</sub>
- COOH be in this indicator?

(Show how you got [H<sub>3</sub>O<sup>+</sup>]) (2)

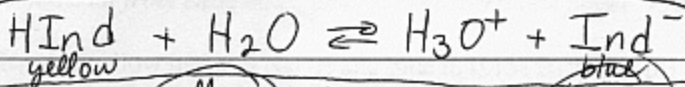
$$[H_3O^+] = \sqrt{C_0 K_a} = \sqrt{0.10 (1.8 \times 10^{-5})}$$

$$[H_3O^+] = 1.34 \times 10^{-3} M$$
$$pH = 2.87$$

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)



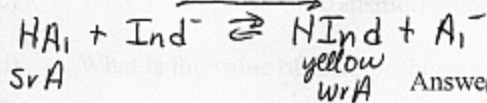
- b) What colour is HInd? (1)
- yellow
- (1) What colour is Ind
- <sup>-</sup>
- ? (1)
- blue
- (1)

- c) HInd is green in the range pH = 5.4 to pH = 6.2. Determine the K
- <sub>a</sub>
- of HInd. (1)

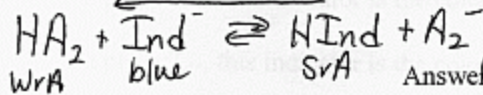
$$pK_a = pH = 5.8$$

$$K_a = 2 \times 10^{-6}$$
 (1)

- d) When a few drops of HInd are added to a weak acid HA
- <sub>1</sub>
- , the colour is yellow. Which is the stronger acid, HInd or HA
- <sub>1</sub>
- ? (1)

Answer: HA<sub>1</sub> is the stronger acid. (1)

- e) When a few drops of HInd are added to a weak acid HA
- <sub>2</sub>
- , the colour is blue. Which is the stronger acid, HInd or HA
- <sub>2</sub>
- ? (1)

Answer: HInd is the stronger acid. (1)

- f) Which acid is stronger, HA
- <sub>1</sub>
- , or HA
- <sub>2</sub>
- ? (1)
- HA<sub>1</sub>
- (1)

- g) List the acids HInd, HA
- <sub>1</sub>
- , and HA
- <sub>2</sub>
- in order of strength from strongest to weakest. (1) (1)

HA<sub>1</sub> > HInd > HA<sub>2</sub>

- h) List the bases Ind
- <sup>-</sup>
- , A
- <sub>1</sub>
- <sup>-</sup>
- , and A
- <sub>2</sub>
- <sup>-</sup>
- , in order of strength from strongest to weakest. (1) (1)

A<sub>2</sub><sup>-</sup> > Ind<sup>-</sup> > A<sub>1</sub><sup>-</sup>