Name SAMPLE

IB acids and bases test

In part one, each student will be given a solution of a strong acid or a weak base with the molarity provided to you.

In part two, each student will be given a weak acid or base and it's corresponding dissociation constant

For both parts show all work clearly for credit.

SAMPLE - YOURS WILL VARY

Part one: Strong acids and bases .0025 HCl

1. You are given 100.0 mL of a ____M solution of _____

2. Is your solution acidic or basic? Explain by showing how H_3O^+ or OH^- exists in the aqueous solution.

ACIDIC: $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

3. Calculate the pH of your solution

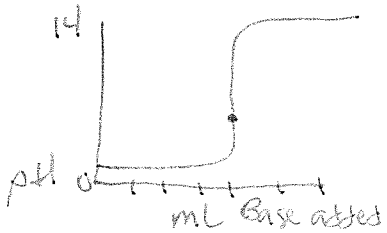
$-\log[H_3O^+] = pH$; $-\log 0.0025 = 2.60$

4. Provide a listed procedure to determine the pH of your solution by titration.

1. Place 10.0mL of your acid in an erlenmeyer flask; add 1 drop indicator (phenolphthalein)
2. Fill a buret with 1.00 M NaOH and add dropwise to erlenmeyer flask to a pale pink endpoint. 3. Calculate concentration using $C_1V_1 = C_2V_2$ then pH as above.

5. Show a reasonable complete titration curve for your titration. Include all relevant units and labels.

- strong acid: start at a very low pH
- continue past the endpoint (mark it)
- strong base - finish at a very high pH.



6. Calculate the number of H_3O^+ and OH^- ions in your solution

$$0.0025\ \frac{mol\ H_3O^+}{L} \times 0.1\ L \times \frac{6.02\times10^{23}\ ions}{mol} = \boxed{1.51\times10^{20}\ H_3O^+\ ions}$$

$$[H_3O^+][OH^-] = 10^{-14}$$

$$[OH^-] = \frac{10^{-14}}{[H_3O^+]} = \frac{10^{-14}}{.0025\ M} = 4.00\times10^{-12}\ M$$

$$\frac{4.00\times10^{-12}\ moles\ OH^-}{L\ solution} \times 0.1\ L \times \frac{6.02\times10^{23}\ ions}{mol} = \boxed{2.41\times10^{11}\ OH^-\ ions}$$

7. Provide a procedure to lower the pH by one unit

moles HCl before: $\frac{.0025\ mol}{L} \times 0.1\ L = .00025\ mol\ HCl$

moles HCl after

pH = 1.60 ; $10^{-pH} = [H_3O^+] = [HCl]$; $10^{-1.60} = \frac{.025\ mol}{L} \times 0.1\ L = .0025\ mol\ HCl$

$.0025\ mol - .00025\ mol\ HCl =$

$.00225\ mol\ HCl$ should be added.

$.00225\ mol\ HCl \times \frac{36.45\ g\ HCl}{mol\ HCl} = .082\ g$

Add 0.082 g pure HCl

8. Provide a procedure to raise the pH by one unit

pH 3.60 needed. $10^{-3.60} = 2.51\times10^{-4}$

$.0025\ mol$ (before) $- .00025\ mol$ (after) $= 2.25\times10^{-3}$ mol HCl removed

to remove 2.25×10^{-3} mol HCl add 2.25×10^{-3} mol NaOH

$2.25\times10^{-3}\ mol\ NaOH \times \frac{40.0\ g\ NaOH}{mol\ NaOH} = .090\ g\ NaOH$

Add 0.090 g NaOH

Part two: Weak acids and bases

9. You are given 100.0 mL of a 1.4 M solution of $HC_2H_3O_2$ which has a Ka/Kb of 1.8×10^{-5}

10. Is your solution acidic or basic? Explain by showing how H_3O^+ or OH^- exists in the aqueous solution.

IT IS ACIDIC SINCE IT FORMS H_3O^+ IN WATER:

$$HC_2H_3O_2 + H_2O \rightleftharpoons H_3O^+ + C_2H_3O_2^-$$

11. Calculate the pH of your solution

Fast method: $1.8 \times 10^{-5} = \frac{x^2}{1.4}$; $x = [H_3O^+] = 5.020 \times 10^{-3} M$

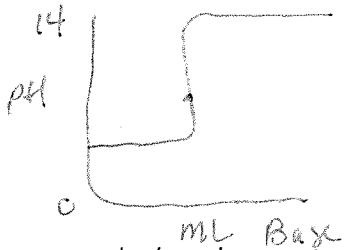
$pH = -\log 5.02 \times 10^{-3} M = \boxed{2.30}$

Fastest: $pH = -\log\sqrt{Ka \cdot conc} = -\log(1.8 \times 10^{-5} \times 1.4)^{1/2} = 2.30$

12. Provide a listed procedure to determine the pH of your solution by titration.

1. Place 10.0 mL of your unknown acid in a flask
2. add 1 drop phenolphthalein
3. Fill a buret with 1.00 M NaOH
4. titrate to a pale pink endpoint.

13. Show a reasonable complete titration curve for your titration. Include all relevant units and labels.



weak acid: start at 1-2

show your end point with a dot go past just because.

strong base: finish at ~14.

14. Calculate the number of H_3O^+ and OH^- ions in your solution

$$\frac{5.02 \times 10^{-3}\ mol\ H_3O^+}{L} \times 0.1\ L \times \frac{6.02 \times 10^{23}\ H_3O^+\ ions}{mol} = \boxed{3.02 \times 10^{20}\ H_3O^+\ ions}$$

$(H_3O^+)(OH^-) = 10^{-14}$

$$[OH^-] = \frac{10^{-14}}{5.02 \times 10^{-3}} = 2.00 \times 10^{-12}\ \frac{mol}{L} \times 0.1\ L \times \frac{6.02 \times 10^{23}\ OH^-\ ions}{mol}$$

$$= \boxed{1.20 \times 10^{11}\ OH^-\ ions}$$

15. Provide a procedure to lower the pH by one unit

Add HCl until [H+] is enough...

After $10^{-pH} = [H_3O^+]$; $10^{-1.3} = \frac{0.050\ mol}{L} \times 0.1\ L = .005\ mol$

Before $10^{-2.3} = \frac{0.005\ mol}{L} \times 0.1\ L = 0.0005\ mol$; need to add 0.005 - 0.0005 mol HCl = .0045 mol HCl

$\times 36.45\ g/mol$,

$= 0.164\ g\ HCl$,

Add 0.164g HCl

16. Provide a procedure to raise the pH by one unit

Add OH^- until enough H+ is consumed

need H+ to be $10^{-3.3} = 0.00050\ M \times 0.1\ L$

$= .000050\ mol$

H is at $0.005\ M \times 0.1\ L$

$= 0.0005\ mol$ → add .0045mol NaOH

$.0045\ mol\ NaOH \times \frac{40.0\ g}{mol} = .18\ g\ NaOH$

Add 0.18g NaOH.