Acids and Bases

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学生实验安全承诺书
Student Experiment Safety Requirements

为保障学生个人和实验室的安全，学生进入实验室之前，请仔细阅读一下《学生实验安全承诺》：
In order to ensure the safety of students and laboratory，before the students enter the lab, please carefully read the " Student Experiment Safety Requirements " :

1. 初次进入化学实验室前自愿接受安全教育，了解使用水、电、气以及化学试剂的基本知识和紧急事故处理办法；
First time entering the lab, everyone is obliged to attend safety training, regarding general instructions on the usage of water, electricity and chemical reagents as well as emergency respond procedures.

2. 做实验前，根据所做实验的安全要求做必要的准备和充分的预习，在得到教师允许的情况下进入实验室，开始实验；
Before conducting any lab work, everyone is required to prepare himself according to safety requirements and to preview the lab manual carefully. Only after receiving the permission by instructor/TA can one start the actual lab work.

3.进入实验室穿实验服，实验操作过程中佩戴防护眼镜，不穿短裤、短袖衬衫、裙子、高跟鞋、拖鞋、凉鞋等进入实验室；
Lab coats, goggles and proper dressing are required in the lab. Inappropriate dressing includes (but not limited to) shorts, short sleeve shirt, dresses/ skirts, high heels, sandals/slippers, etc.

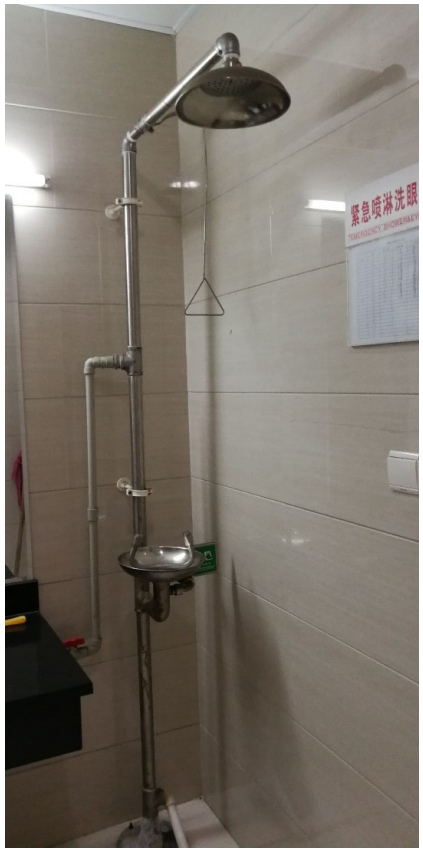
4. 在实验室内不吸烟、不饮食、不大声喧哗及追逐打闹，实验时思想集中，按照实验步骤认真操作，未经允许不随意改动实验操作前后次序；
No smoking, no eating, no shouting/running, are allowed in the lab. Please concentrate when conducting experiments. Lab procedures shall not be altered unless instructed to.

5. 严格按照要求取用各种化学试剂，不浪费化学试剂、不随意混合各种试剂或将试剂倒入水槽，按规定回收或将试剂倒入指定废液缸，不将实验室内物品带出实验室。
Please follow the instructions carefully to when handling chemicals. Please do NOT mix the chemicals randomly. All wastes shall be disposed to the specifically assigned containers (NOT the sink). All lab items must be remained in the lab!

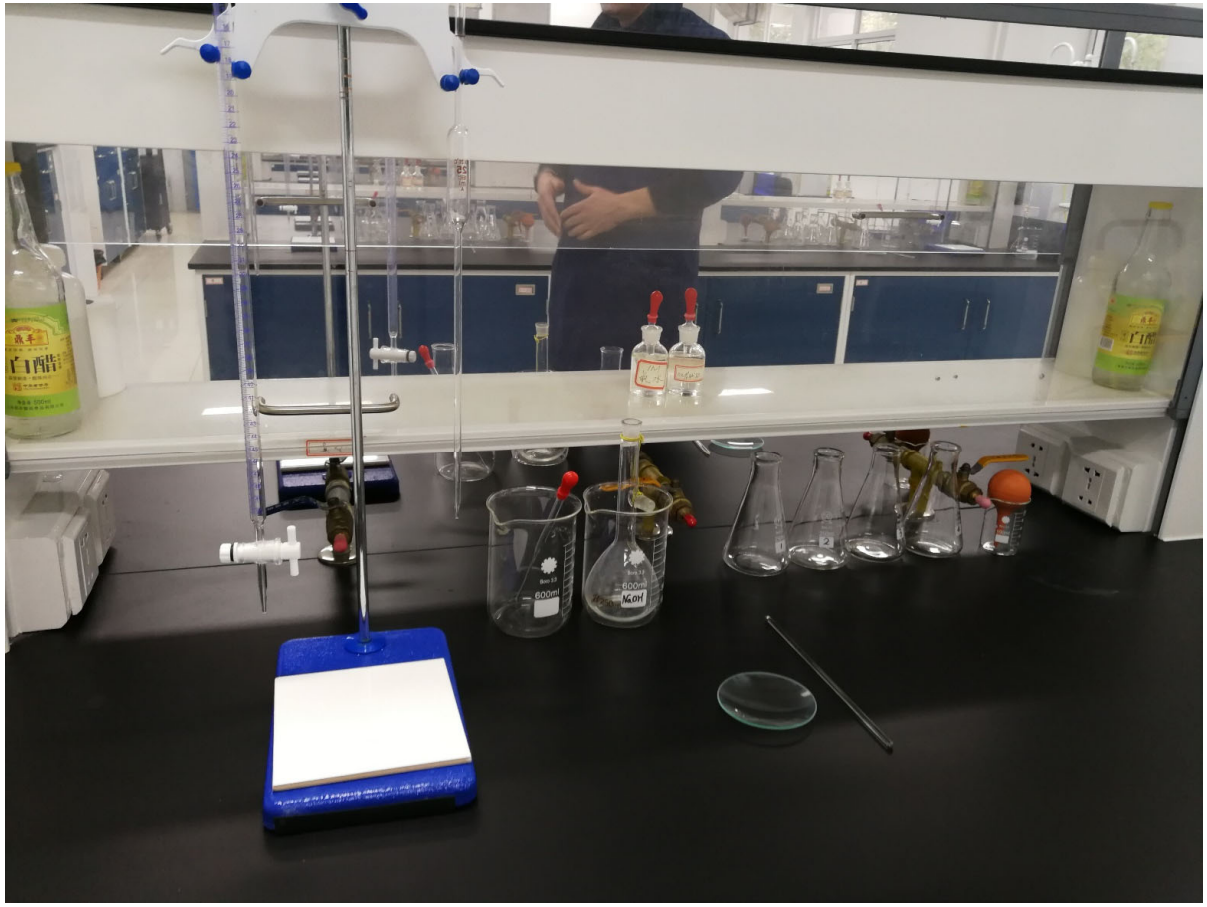
6. 实验结束后，关闭门、窗、水、电、气等阀门，经指导教师检查认可后，再离开实验室。
After finishing the experiment, please shut the doors and windows as well as turn off water, electricity and gases. Checking out the lab only after being approved by instructor/TA.

Where does waste go?

Where are the safety staffs?



How my work station look like?

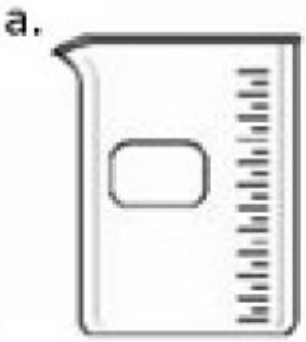


About the Grading…

GRADING GUIDE	MAX. POINTS	MAX. % GRADE
5 EXPERIMENTS 150 POINTS EACH AS FOLLOWING: a. *PLE: PRE-LAB EXERCISES 30 POINTS* *Including the pre-lab quiz grade.* b. *PLQ: POST-LAB & DATA SHEET 40 POINTS* c. *EXPT'L OPERATION LAB WORK 50 POINTS* *"TA gives grade at end of experiment"* d. *ALR: AFTER-LAB REPORT 30 POINTS*	750	75%
EXPERIMENTAL DESIGN REPORT: Relies on experiments 1 & 3 analyzing calcium (Ca) in commercial products	50	5%
FINAL EXAM: CLOSED BOOKS & NOTES	150	15%
FINAL PPT ON SELECT E1-E5 EXPERIMENT: Each group to present one assigned experiment during the 8th week of lab. You must document your experimental work with few photos to include in your reports and presentation.	50	5%
TOTAL	1000	100%

What is this?

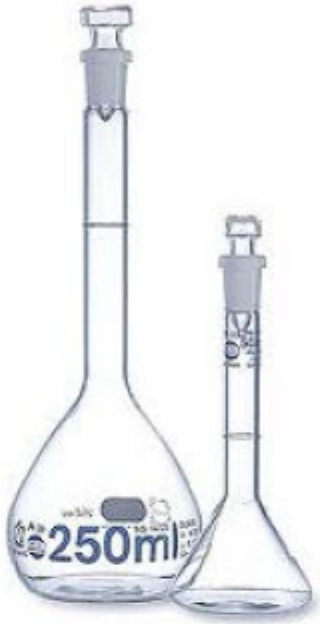
Beaker



Buret

Volumetric Pipet

Graduated cylinders



Volumetric flasks

What is this?

Glass funnel

Test tubes

Wash bottle

Erlenmeyer flask

OBJECTIVES

- A. Classify common household chemicals as either acids or bases using a strip of universal indicator paper.
- B. Develop an understanding of the pH scale.
- C. Titrate a sample of vinegar to determine the concentration of acid.

BACKGROUND

- Acid & Base Ionization Constants (Equilibrium constant, i.e. K_a & K_b)
- The pH scale
- Calculating the pH
- Indicators
- Titration

Acid & Base Ionization Constants

ALL CONCENTRATIONS AT EQUILIBRIUM

weak acid: $CH_3COOH + H_2O \Leftrightarrow H_3O^+ + CH_3COO^-$

Acid dissociation constant: $K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$

weak base: $NH_3 + H_2O \Leftrightarrow NH_4^+ + OH^-$

Base ionization constant: $K_b = \dfrac{[NH_4^+][OH^-]}{[NH_3]}$

Acid and base ionization constants are the measure of the strengths of acids and bases.

The pH scale

- $pH = - \log[H_3O^+]$

- neutral solution: $[H_3O^+] = [OH^-] = 10^{-7}$ M pH = 7.0

  acidic solution: $[H_3O^+] > 10^{-7}$ M pH < 7.0

  basic solution: $[H_3O^+] < 10^{-7}$ M pH > 7.0

Calculating the pH

- What is the pH of 0.10 M propanoic acid (C_2H_5COOH,HPr), a weak acid?
- Solving the problem: i=Initial, C=Change, E= Equil.

	HPr	⇆	Pr^-	+	H^+	$K_a = 1.3 \cdot 10^{-5}$ M
Initial	0.10		0		0	
Change	-x		+x		+x	
Equil.	0.10-x		x		x	

$$K_a = \frac{[H^+][Pr^-]}{[HPr]} = 1.3 \times 10^{-5}$$

At Equilibrium & 25^0C

Calculating the pH

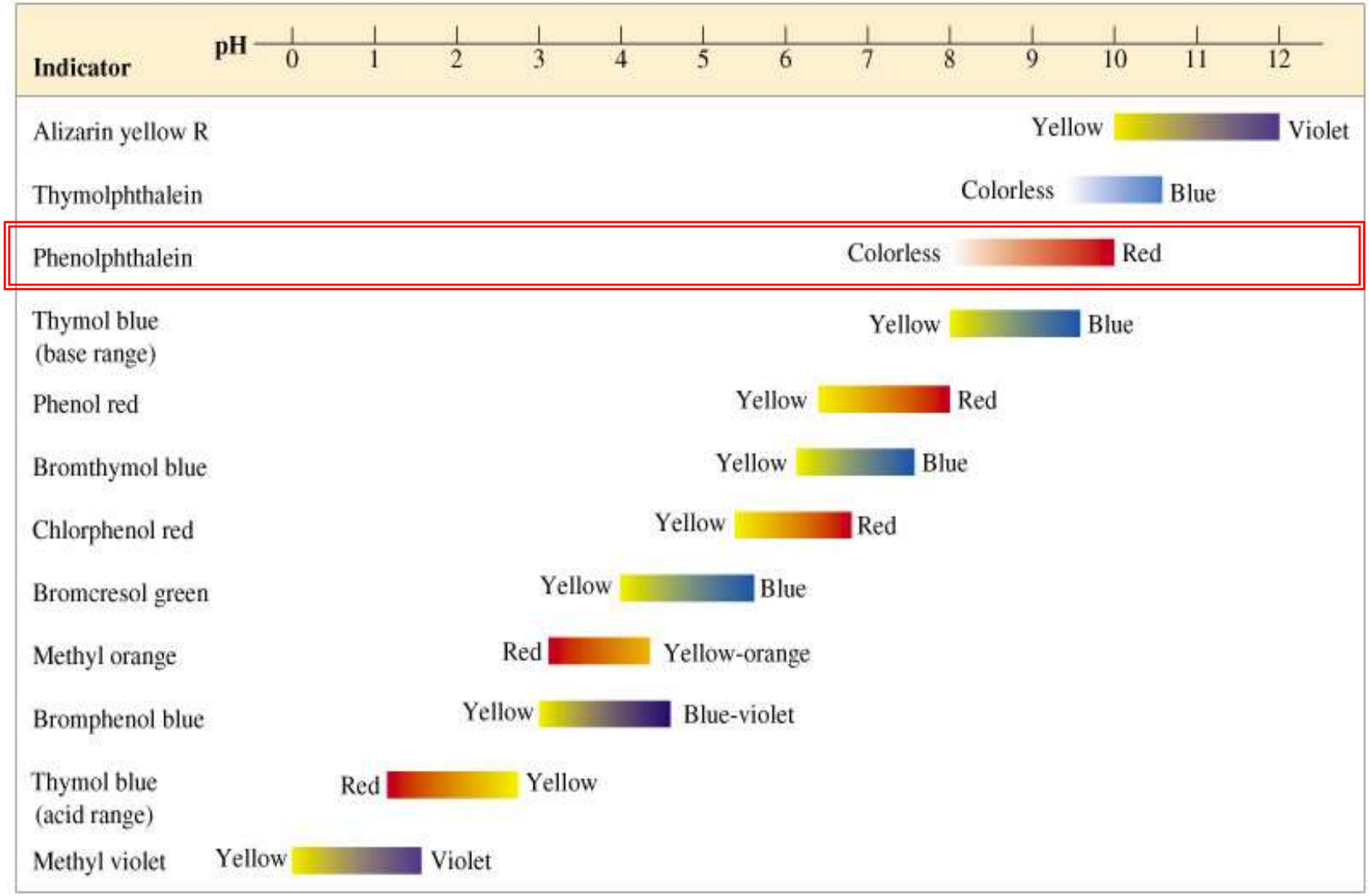
$$K_a = \frac{[\mathrm{H^+}][\mathrm{Pr^-}]}{[\mathrm{HPr}]} = \frac{x \times x}{0.10 - x} = 1.3 \times 10^{-5}$$

$$[H^+] = x = \sqrt{c_{\mathrm{HPr}} K_a} = \sqrt{0.10 \times 1.3 \times 10^{-5}} = 1.1 \times 10^{-3} M$$

pH = -lg[H$^+$] = 2.96

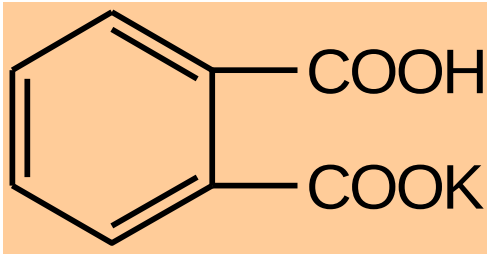
Note: initial [HBr] = 0.1M & equilibrium [HBR] = 0.1M – x = approx. 0.1M because x is much smaller than 0.1M (not significant, 1SF)

Indicators


Indicator
pH
0 1 2 3 4 5 6 7 8 9 10 11 12
Alizarin yellow R
Yellow
Violet
Thymolphthalein
Colorless
Blue
Phenolphthalein
Colorless
Red
Thymol blue (base range)
Yellow
Blue
Phenol red
Yellow
Red
Bromthymol blue
Yellow
Blue
Chlorphenol red
Yellow
Red
Bromcresol green
Yellow
Blue
Methyl orange
Red
Yellow-orange
Bromphenol blue
Yellow
Blue-violet
Thymol blue (acid range)
Red
Yellow
Methyl violet
Yellow
Violet

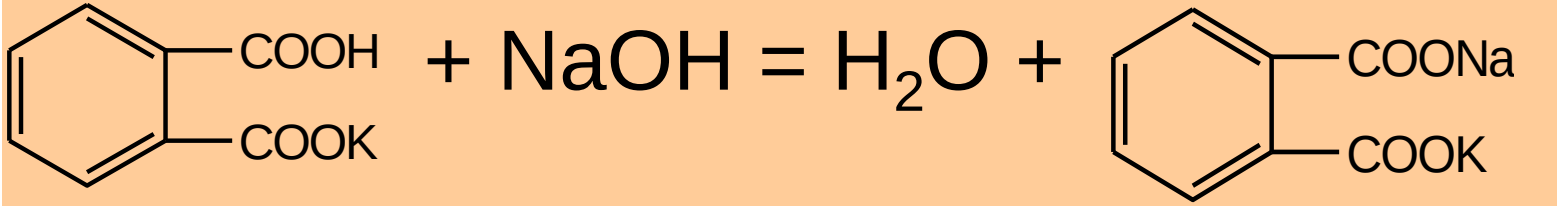
Phenolphthalein

Concentration of NaOH solution



Potassium hydrogen phthalate, KHP,$KHC_8H_4O_4$

(Standard substance, FW 204.233)



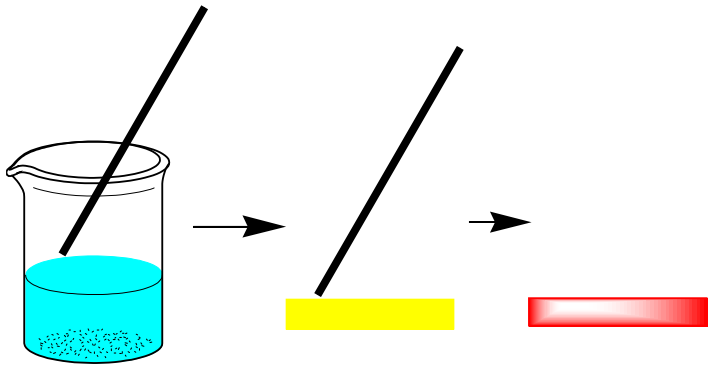
$$C_{NaOH}V_{NaOH} = m_{KHP}/M_{KHP}$$

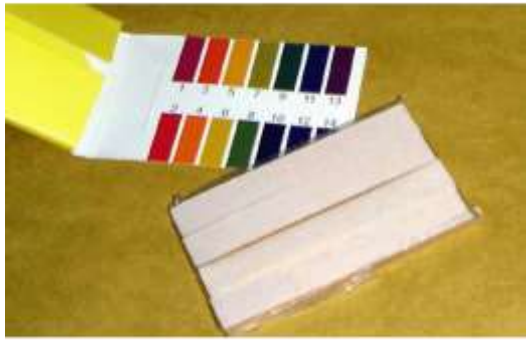
PROCEDURE-- Part A.

(EACH 2 STUDENTS 1TRIAL)

- ***Relative Acidity/Basicity of Common Household Products***

1. Select one or two household products and test the pH with a strip of universal indicator paper. Record the results.
2. Repeat procedure in 1. but use 1 or 2 drops of 1M $NH_3.H_2O$. Record the results





PROCEDURE-- Part B.1

(EACH 2 STUDENTS 3 TRIALS)

Exact concentration of NaOH solution?

1. Wash the glassware by soap, tap water and de-ionized water, 3 times each.

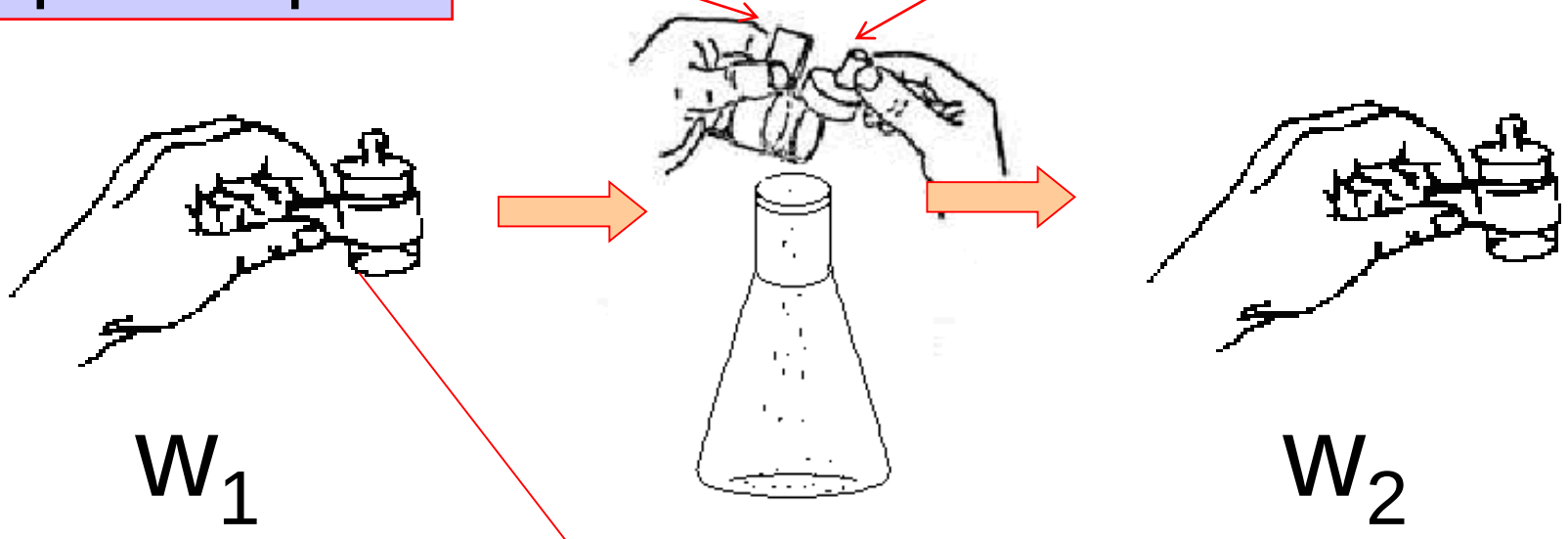
2. Rinse the buret and pipet with the corresponding solutions.

3. Weigh out 0.4000-0.6000g KHP into 3 labeled Erlenmeyer flasks, record each weight. Add 30-40mL de-ionized water to entirely dissolve KHP and add 1-2 drops of phenolphthalein to the flasks.

Scheme 1

Paper strip 1

Paper strip 2



W_1

W_2

$\Delta w = w_1 - w_2$

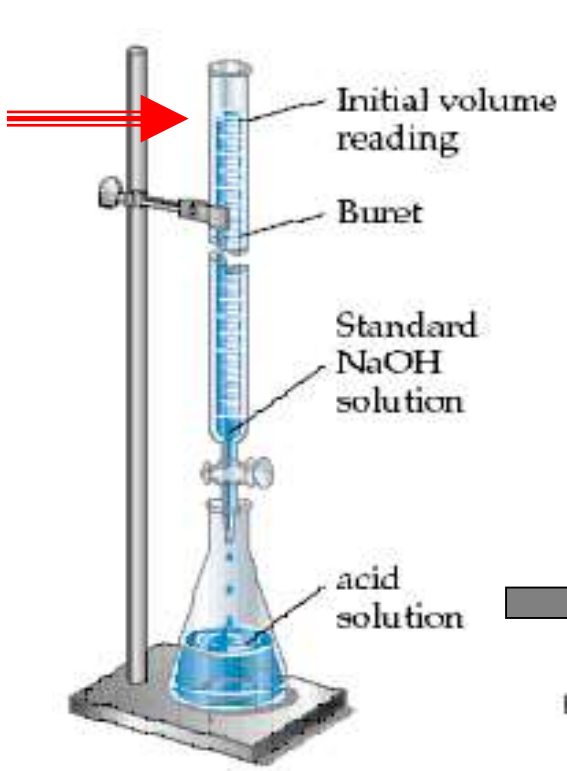
Weighing bottle

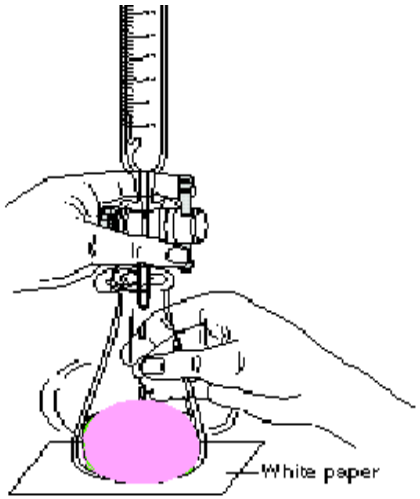
PROCEDURE-- Part B.2

(EACH 2 STUDENTS 3 TRIALS)

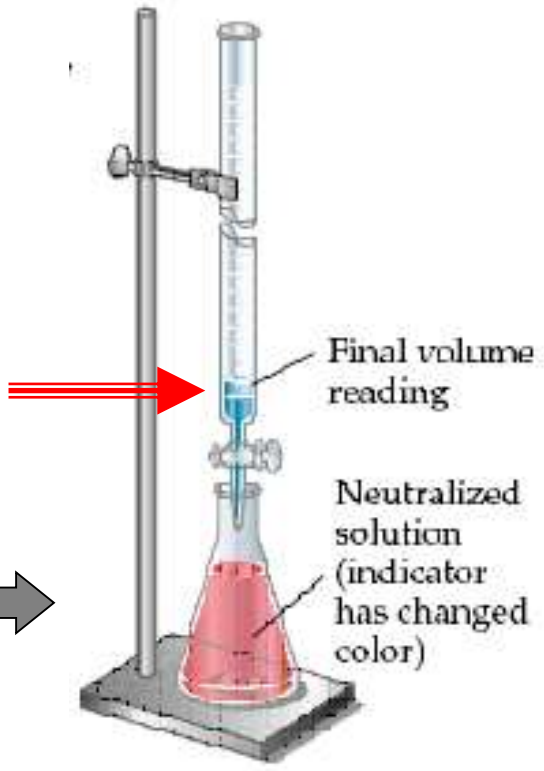
4. Add 0.1M NaOH solution into the buret and drive away air bubbles, record initial volume V_1 of the buret (-/+0.02mL).
5. Slowly add the 0.1M NaOH solution drop-wise from the buret to the KHP solution, swirling the flask after each addition. Continue until the endpoint is reached. Record the final volume V_2.
6. Repeat steps 4-5 for a second and third trial.

Scheme 2





Delivery of liquid from a buret



V_1

V_2

$$\Delta V = V_2 - V_1$$

PROCEDURE-- Part C.1

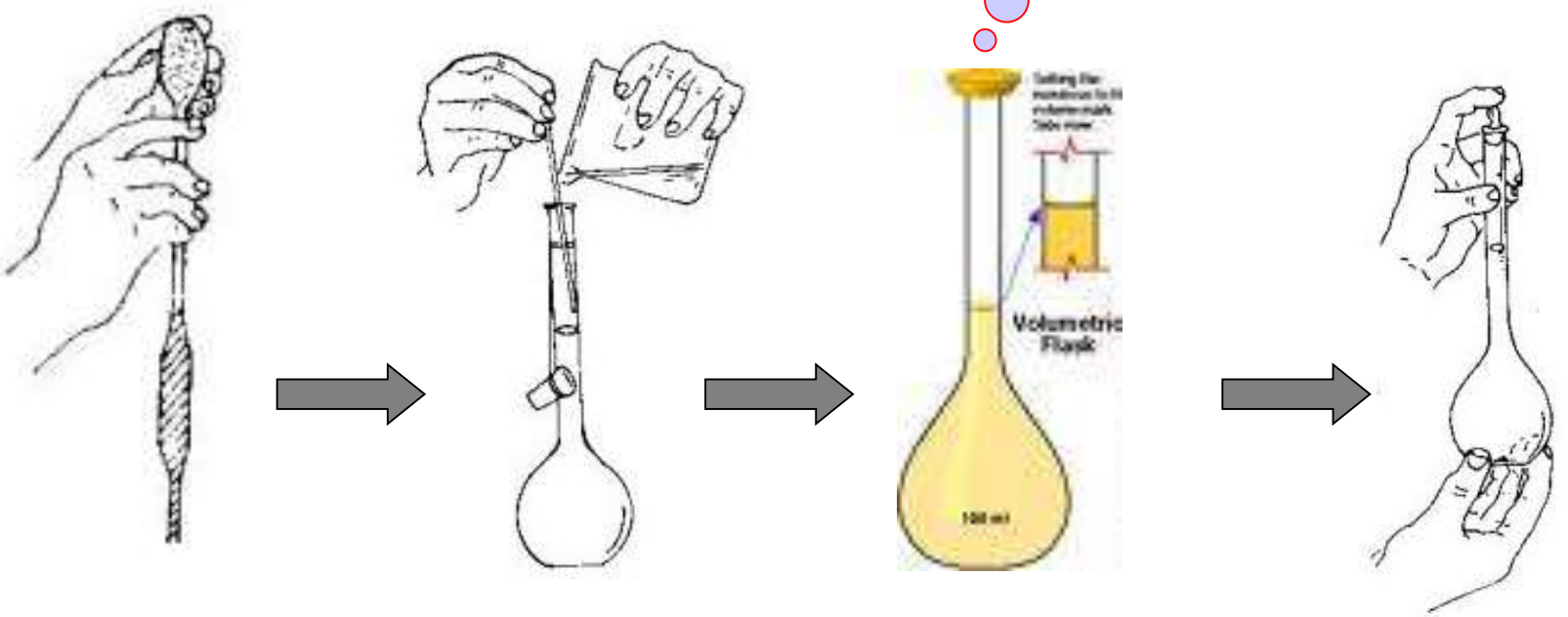
(EACH 2 STUDENTS 1 TRIAL)

Titration of vinegar solution

1. Pipet 25.00mL of the vinegar into an 250.00mL volumetric flask, add de-ionized water to the calibration line and shake 20 times.
2. Pipet 25.00mL above solution into 3 Erlenmeyer flasks, add 1 drop of phenolphthalein to the flasks.

Scheme 3

Attention!Add drop-wise by a dropper!



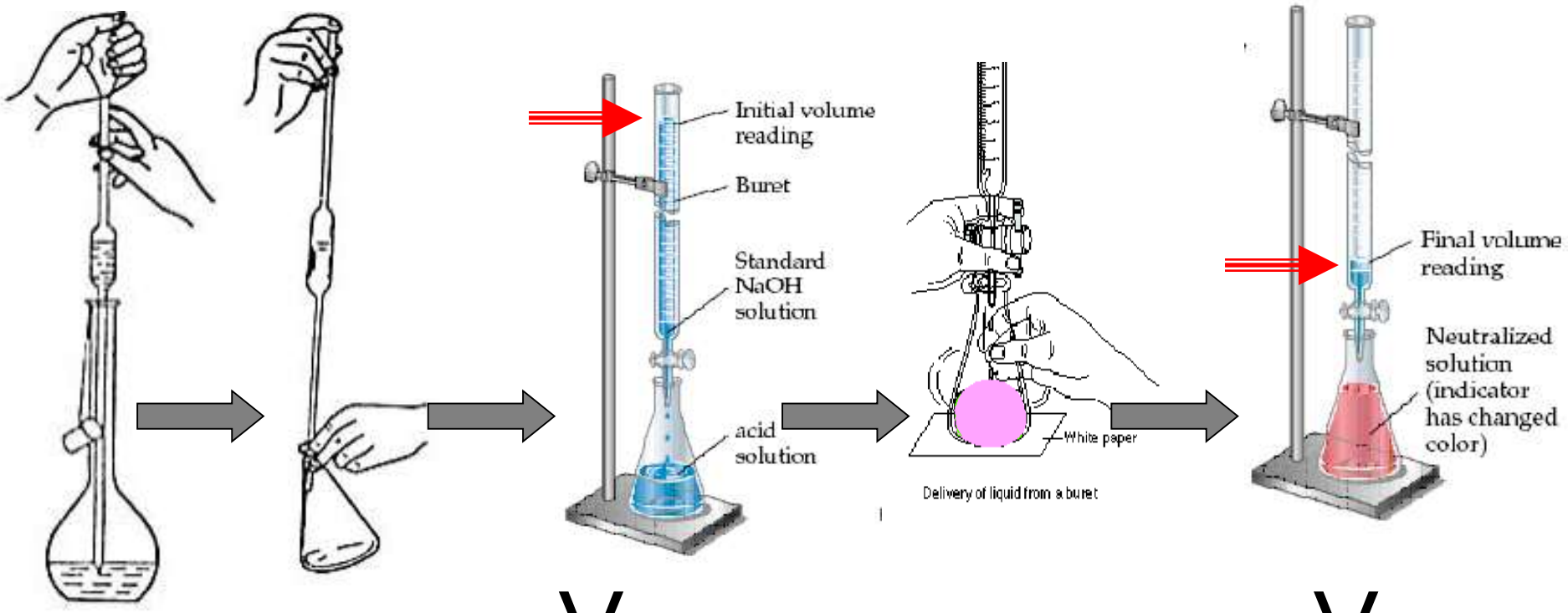
Invert 20 times

PROCEDURE-- Part C.2

(EACH 2 STUDENTS 3 TRIAL)

3. Add 0.1M NaOH solution into the buret and drive away air bubbles, record initial volume V_1 of the buret (-/+0.02mL).
4. Slowly add the 0.1M NaOH solution drop-wise from the buret to the vinegar, swirling the flask after each addition. Continue until the endpoint is reached. Record the final volume V_2(-/+0.02mL).
5. Repeat steps 3-4 for a second and third trial.

Scheme 4



V_1 V_2

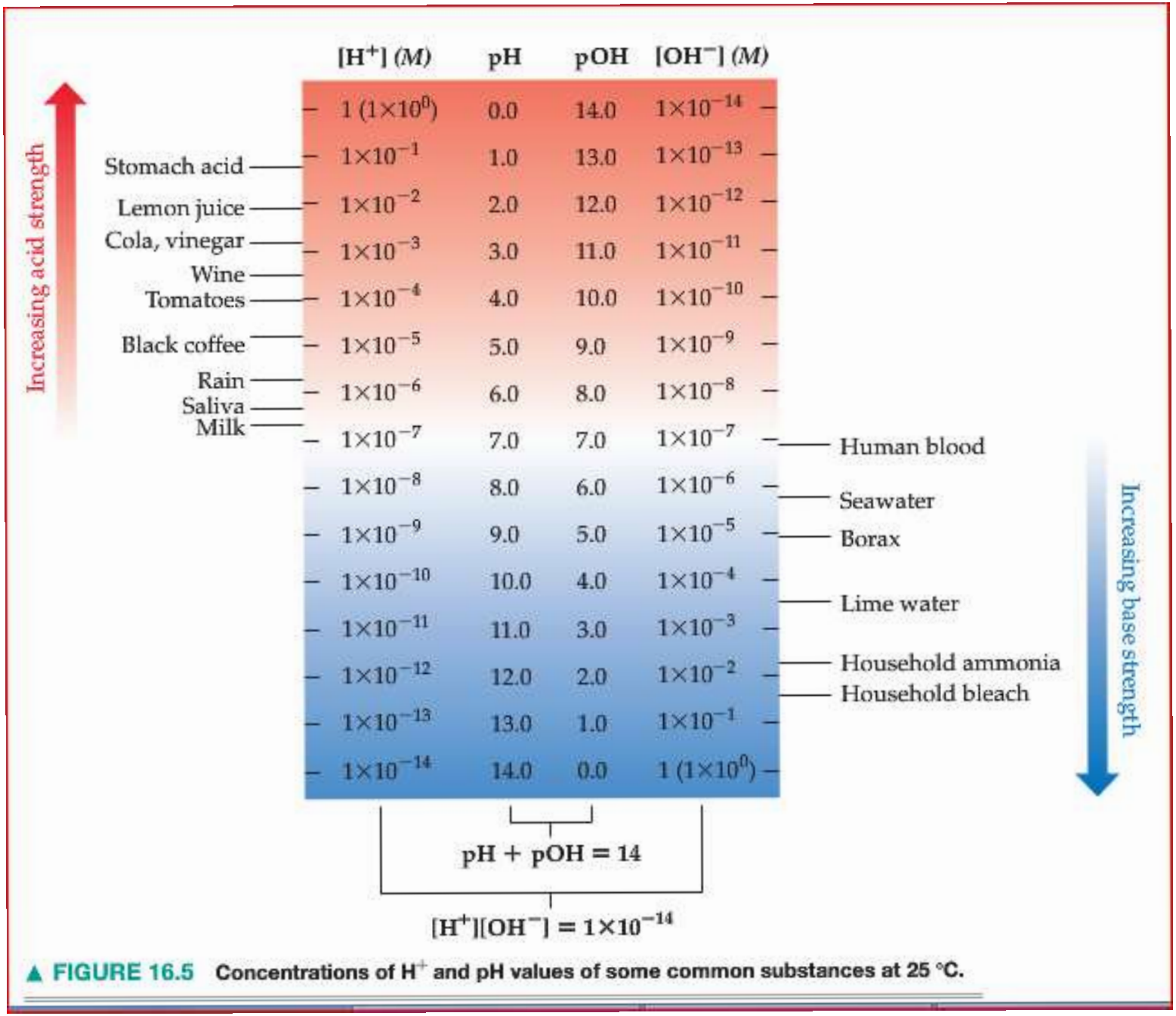
$$\Delta V = V_2 - V_1$$

SAMPLE DATASHEET

VC211 DATASHEET FOR EXPERIMENT: E1 ACIDS & BASES

SECTION: _____ TA: _____ LAB ROOM: _____

			Household pH		KHP Accurate Weight			KHP Titration			Acetic Acid Titration		
GRP	NAME	ID	HSHLD	$NH_3.H_2O$	KHP	KHP	KHP	NaOH	NaOH	NaOH	NaOH	NaOH	NaOH
#	Chinese		pH	pH	(g)	(g)	(g)	V1 (mL)	V2 (mL)	V3 (mL)	V4 (mL)	V5 (mL)	V6 (mL)



▲ **FIGURE 16.5** **Concentrations of H^+ and pH values of some common substances at 25 °C.**

Demo Time