
Lab.343

Experiment (3)

Determination of the saponification rate constant of ethyl acetate in alkaline medium

A. PURPOSES

The purpose of this experiment is to show the reaction of ethyl acetate saponification by hydroxide ions :

is a second-order reaction. In addition, it is also determined the reaction rate constants. This determination is done by titration method.

BASIC THEORY

To determine the rate of a given chemical reaction, it should be determined how fast changes are occur in the concentration of reactants or products.

In general, if a reaction occurs A → B,
the initial substance A and substance B did not exist.

After some times, the concentration of B will increase while the concentration of A will decrease.
Rate law can be determined by conducting a series of systematic experiments on the reaction A + B → C, to determine the reaction order with respect to A the concentration of A is fixed while B concentration varied then determined the rate of the reaction on the concentration variation. As for determining the order of the reaction B, the concentration of B is fixed while the concentration of A varied then measured the rate of the reaction on the concentration variation

Hydrolysis is a chemical decomposition involving breaking of a bond and the addition of elements of water

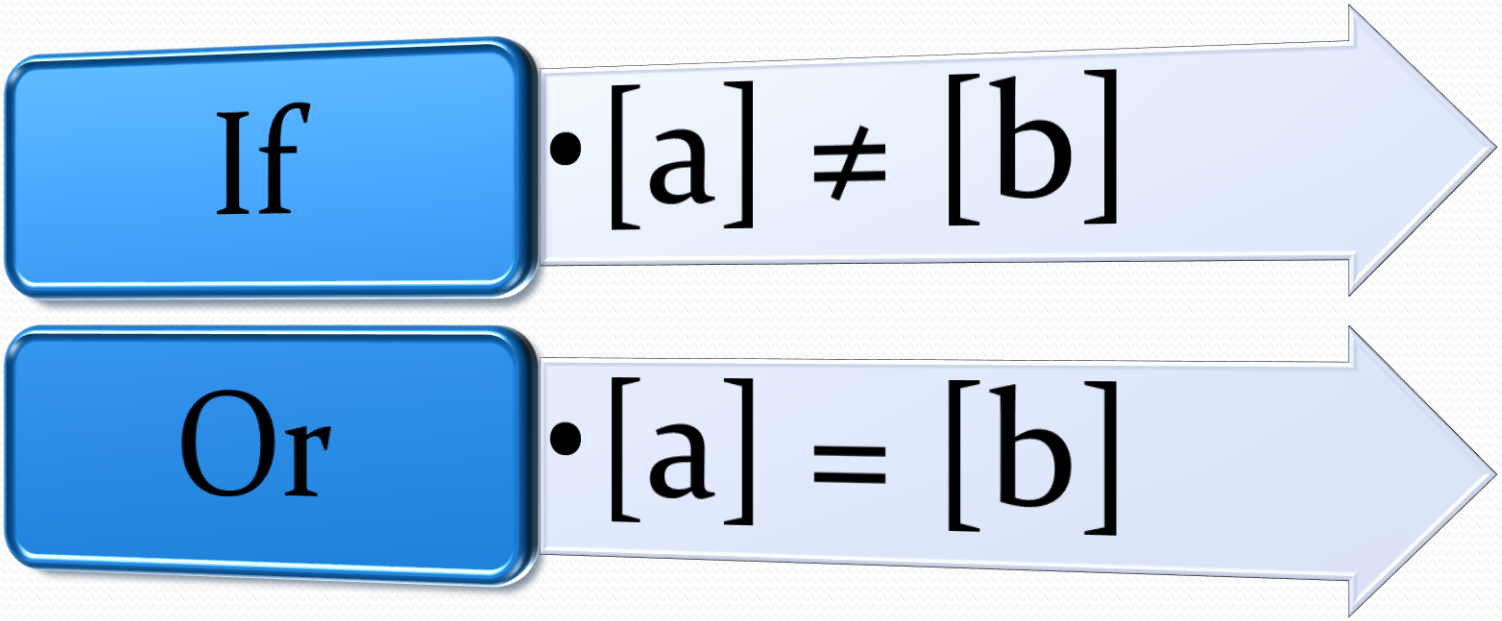
In this hydrolysis of ester (ethyl acetate) with an alkali (sodium hydroxide), HCl was used as catalyst to accelerate it.

$$CH_3COOC_2H_5 + NaOH \xrightarrow{H^+} CH_3COONa + C_2H_5OH$$

t= o	a	b	o	o
t= t	a-x	b-x	x	x

$$R = dx/dt = K\,[CH_3COOC_2H_5\,][NaOH]$$
$$= K\,[\,a-x]\,[b-x]$$

Second order reaction equation



- $[a] \neq [b]$

$$dx/dt = K (a-x) (b-x)$$

$$dx/ (a-x) (b-x) = K\, dt$$ *by integration*

$$K = [2.303/ t (a-b)] [\log b(a-x)/a(b-x)]$$

- [a] = [b]

$$dx/dt = K(a-x)(b-x)$$

$$dx/dt = K(a-x)^2$$

$$dx/(a-x)^2 = K\,dt$$

by integration : $\int_0^x dx/(a-x)^2 = \int_0^t K\,dt$

$$1/a-x = Kt + \text{constant}$$

At $t=0$, $x=0$ ⟹ $\text{constant} = 1/a$

$$1/a-x = Kt + 1/a$$

At $t=t_{1/2}$, $x = a/2$

$t_{1/2} = 1/ ak$

unit of $t_{1/2}$ = time

$K = 1/a\ t_{1/2}$

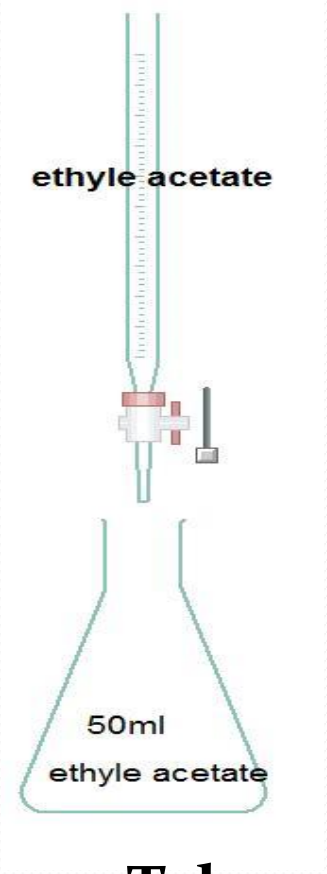
unit of K = L mol^{-1} $time^{-1}$

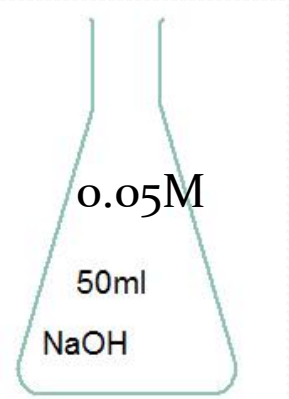
Prepare:

concentration	Volume	Liquid	Solid
0.05M	100ml	$CH_3COOC_2H_5$	NaOH
0.025M	250ml	HCl	NaOH

Procedure:

1-

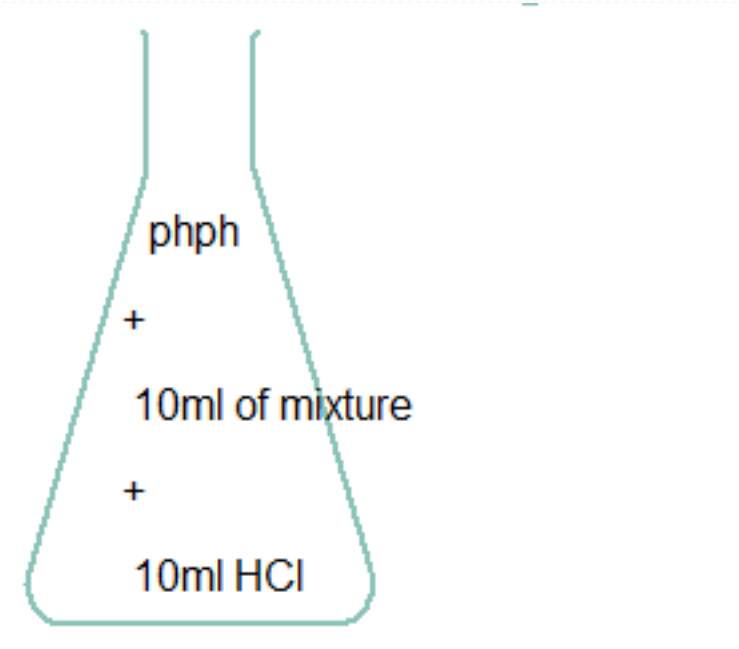




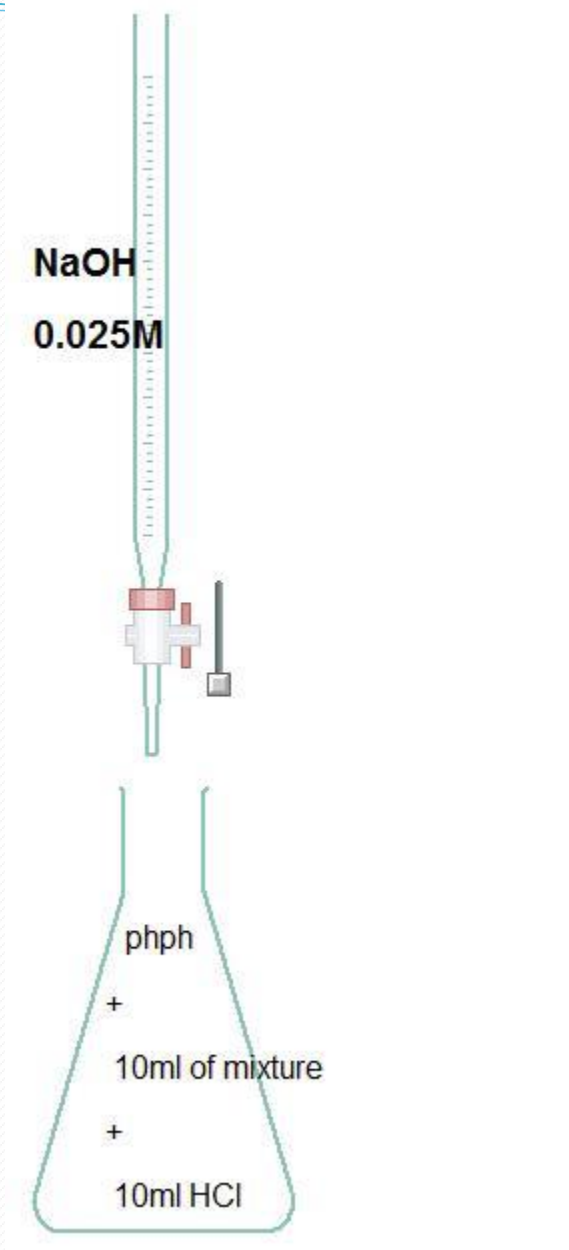
Take room temperature
10 minutes

2-pour base to ester (fast) then open stop watch with strong shaking.

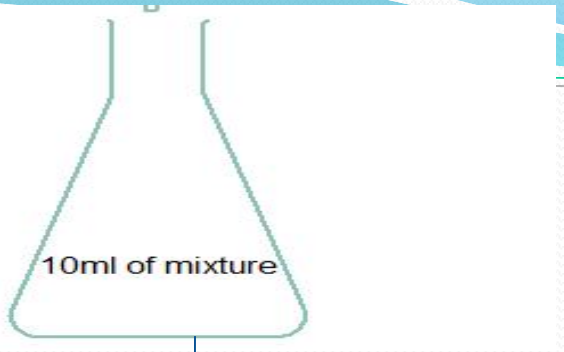
3-At time = 2,4,7,… take 10 ml of mixture



4-



time	V (NaOH)≡ X ≡ HCl	a-x = 10 -x	1/a-x
2			
4			
7			
10			
14			
18			
23			
28			
38			



Free(a-x)
React with HCl
Ex. 8ml

t=4 min

NaOH 10 ml
10ml HCl

t=2 min

Free(a-x)
React with HCl
Ex. 9ml

Product(X)
Remaining of HCl
Ex. 2ml

Product(X)
Remaining of HCl
Ex. 1ml

- HCl react ≡free NaOH(unreacted)(a-x)
- HCl unreacted ≡ V NaOH ≡ reacted NaOH+ reacted

ethyle acetate ⟶ product ≡ X