Cerritos Community College

Organic Chemistry 211 Laboratory

Nucleophilic Substitution of Alkyl Halides

(Part 4: Reaction of Ethyl Bromide with Hydroxide Ion, an S_N2 Reaction)

TO BE PERFORMED IN PAIRS

Waste Disposal: All the reaction mixtures should be placed in the halogenated organic waste container.

Objective: To determine the rate constant for the S_N2 reaction of ethyl bromide with hydroxide ion, where the hydroxide ion substitutes for the bromide leaving group.

Reaction Equation:

$$EtBr + OH^- \longrightarrow EtOH + Br^-$$

Experiment Overview:

The rate constant for the S_N2 reaction shown above will be determined based on monitoring the decreasing concentration of the reactant (OH^- ion). The concentration of the unreacted hydroxide ion will be determined via quenching (stopping) the reaction through dilution with ice-cold water, and then immediately titrating the leftover hydroxide ions with hydrochloric acid.

Procedure:

Prepare the following in Erlenmeyer flasks, and cork them (per pair):

a) 200 mL of 0.10 M HCl
b) 50 mL of 0.40 M ethyl bromide in ethanol
c) 50 mL of 0.40 M potassium hydroxide (CO_2 free) in ethanol.

Place the stock solutions of ethyl bromide and potassium hydroxide in a water bath at 40^{o}C and allow them to come to equilibrium.

In a 250 mL Erlenmeyer flask, pipette exactly 50 mL of ethyl bromide solution and exactly 50 mL of the KOH solution. The reaction time starts as soon as ethyl bromide and KOH are mixed. Record the reaction time with the stopwatch. Mix the contents of the flask thoroughly and place it in a 40^{o}C water bath. Use a 1 liter beaker for the water bath. Immediately take 10 mL aliquot (portion) and deliver it into a 250 mL Erlenmeyer flask containing 50 mL of ice-cold water. This will quench the reaction, so that the titration could be performed. Titrate rapidly with 0.10 M HCl to the phenolphthalein endpoint. Repeat taking aliquots every 10 minutes for 80 minutes. Draw a table as shown below, for your calculations.

Time (s)	Initial Burette reading (mL)	Final Burette reading (mL)	HCl Volume (mL)	[OH] (M)	1/[OH] (M^{-1})

Plot the values of 1/[OH] versus time. Draw the best fit for straight line and graphically determine its slope. The slope (unit = liter/mole.sec) is the rate constant for the reaction.

For your report:

Show the completed table of data.

Show the graph, completely drawn, and the calculation for the slope.

Needed per group (2 students per group):

50 mL volumetric pipet (2)----------→ 16 per laboratory
0.10 M HCl (200 mL)----------→1600 mL per laboratory
0.40 M ethyl bromide in ethanol (50 mL)----------→400 mL per laboratory
0.40 M potassium hydroxide (CO_2 free) in ethanol(50 mL)---------→ 400 mL per laboratory
1 liter beaker (1)----------→ 8 per laboratory
Phenolphthalein indicator----------→ 2 dropper bottles per laboratory
Stopwatch(1)----------→ 8 per laboratory
Burette(1)----------→ 8 per laboratory