

Making and reacting esters and acyl chlorides

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab

Name: _____ Date: _____ Class: _____

How far does the reaction between ethanoic acid and ethanol go? You will heat the two liquids with a catalyst until equilibrium is reached, then use a titration to find how much acid remains. From this you can calculate the equilibrium constant and test it by predicting the result of a second experiment.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.3.9

Aim

To measure the equilibrium constant K_c for the formation of ethyl ethanoate from ethanoic acid and ethanol by titrating the unreacted acid, and to predict the effect of changing the ethanol amount.

Equipment

- glacial ethanoic acid ($5.7 \text{ cm}^3 = 0.100 \text{ mol}$) and ethanol ($5.8 \text{ cm}^3 = 0.0995 \text{ mol}$, take as 0.100 mol)
- concentrated sulfuric acid, 5 drops
- 100 cm^3 round-bottomed flask, condenser, water bath, anti-bumping granules
- 250 cm^3 volumetric flask, 25.0 cm^3 pipette, burette
- sodium hydroxide, 0.100 mol/dm^3 ; phenolphthalein indicator

Safety

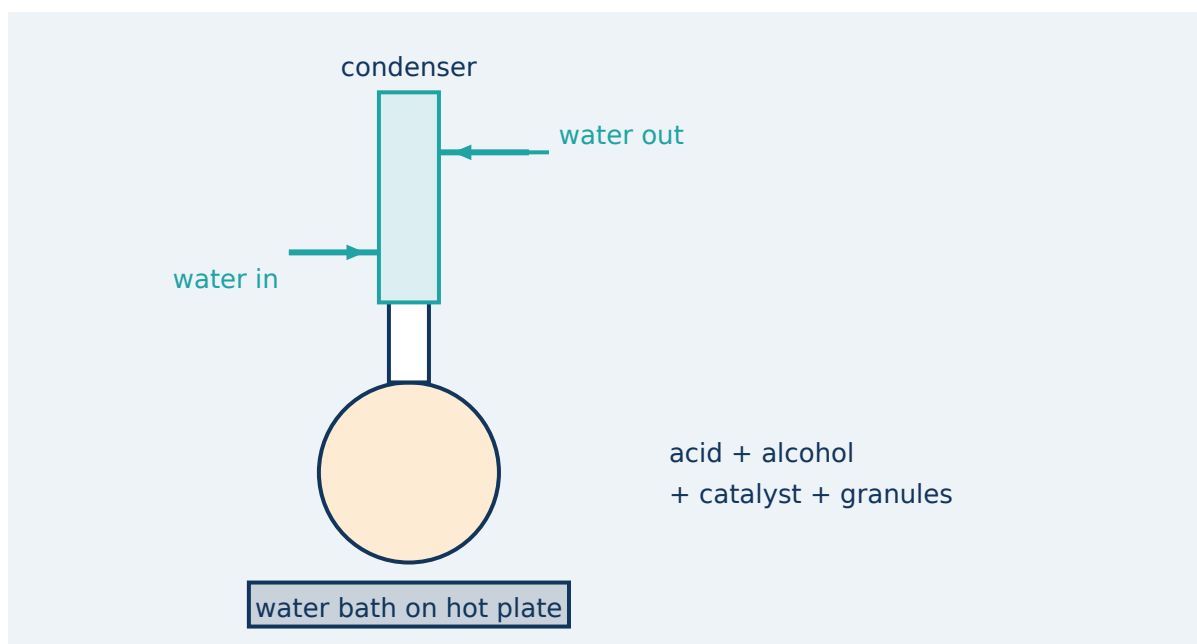
Safety

Concentrated sulfuric acid and glacial ethanoic acid are corrosive: wear goggles and gloves and add the acid with a dropper. Ethanol is flammable, so use an electric water bath, never a naked flame. Keep the condenser water flowing before heating.

Method

1. Measure the acid and the ethanol into the flask, add 5 drops of concentrated sulfuric acid and the granules.
2. Heat under reflux in the water bath for 45 minutes.
3. Cool the flask, then transfer the contents to the 250 cm^3 flask with distilled water washings and make up to the mark.

- Pipette 25.0 cm^3 into a conical flask, add indicator and titrate with $0.100\text{ mol/dm}^3\text{ NaOH}$. Repeat to get concordant titres.
- Run a blank: titrate the same 5 drops of acid catalyst in 25.0 cm^3 of water (diluted in the same ratio).



Heating under reflux for 45 minutes lets the esterification reach equilibrium without losing volatile liquids.

Results

Sample measurements (blank titre = 0.7 cm^3):

Titration	1	2	3
Titre of NaOH / cm^3	34.1	33.9	34.0

Analysis questions

Question 1 Corrected titre

Calculate the mean titre and subtract the blank.

Question 2 Acid left

Calculate the amount of ethanoic acid in the 25.0 cm^3 portion and in the whole mixture.

Question 3 Ester formed

Starting from 0.100 mol of each reactant, calculate the amounts of ester and water at equilibrium.

Question 4 Calculate Kc

Calculate Kc from your results.

Question 5 Quenching and blank

Explain why the mixture was diluted and cooled before titrating, and why the blank was run.

Question 6 Prediction with more ethanol

Predict the titre in a repeat with 0.100 mol of acid and 0.200 mol of ethanol ($K_c = 4.0$). Use x for the amount of ester.

Question 7 Errors and improvements

State two sources of error and one improvement.