

Making and reacting esters and acyl chlorides

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

The model answers use the sample data. The amounts follow from the titre and the blank correction; the equilibrium constant should be close to 4 at room temperature. Show every conversion from cm^3 to dm^3 and the factor of 10 for the dilution.

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

Question 1 Corrected titre

Mean = $(34.1 + 33.9 + 34.0) / 3 = 34.0 \text{ cm}^3$. Corrected = $34.0 - 0.7 = \mathbf{33.3 \text{ cm}^3}$.

Question 2 Acid left

$n(\text{NaOH}) = 0.100 \times 0.0333 = 3.33 \times 10^{-3} \text{ mol} = n(\text{acid})$ in 25.0 cm^3 . Whole mixture ($\times 10$): **0.0333 mol**.

Question 3 Ester formed

Acid used = $0.100 - 0.0333 = 0.0667 \text{ mol}$, so ester = water = **0.0667 mol**. Ethanol left = 0.0333 mol .

Question 4 Calculate Kc

$K_c = (0.0667 \times 0.0667) / (0.0333 \times 0.0333) = \mathbf{4.0}$. Volume cancels because the amounts of products and reactants are equal in number.

Question 5 Quenching and blank

Cooling and diluting slows the reaction so the equilibrium does not shift during titration. The catalyst is also an acid that reacts with NaOH, so the blank **subtracts its contribution**.

Question 6 Prediction with more ethanol

$x^2 / [(0.100 - x)(0.200 - x)] = 4.0$ gives $3x^2 - 1.2x + 0.08 = 0$, so $x = 0.0845 \text{ mol}$. Acid left = 0.0155 mol . In 25.0 cm^3 : $1.55 \times 10^{-3} \text{ mol}$, so titre = **15.5 cm^3** (blank excluded).

Question 7 Errors and improvements

The ester and ethanol are volatile, so some may escape; the indicator end point is judged by eye. Use **a well-sealed condenser** and a longer reflux time, and check equilibrium by repeating with a 60-minute sample.