



Oxford Cambridge and RSA

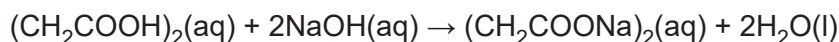
A Level Chemistry A

H432/03 Unified chemistry

Question Set 10

1 A student carries out two experiments in the laboratory based on succinic acid (butanedioic acid), $(\text{CH}_2\text{COOH})_2$.

(a) Aqueous succinic acid can be neutralised by aqueous sodium hydroxide, $\text{NaOH}(\text{aq})$:



This reaction can be used to determine a value for the enthalpy change of neutralisation, $\Delta_{\text{neut}}H$.

The student follows this method:

- Add 50.0 cm^3 of $0.400 \text{ mol dm}^{-3}$ succinic acid to a polystyrene cup.
- Measure out 50.0 cm^3 of 1.00 mol dm^{-3} $\text{NaOH}(\text{aq})$, which is in excess.
- Measure the temperature of both solutions.
- Add the $\text{NaOH}(\text{aq})$ to the aqueous succinic acid in the polystyrene cup, stir the mixture, and record the maximum temperature.

Temperature readings

Maximum temperature of mixture/ $^{\circ}\text{C}$	26.5
Initial temperature of both solutions/ $^{\circ}\text{C}$	21.5

Calculate a value for the enthalpy change of neutralisation, $\Delta_{\text{neut}}H$, in kJ mol^{-1} .

Assume that the density of all solutions and the specific heat capacity, c , of the reaction mixture are the same as for water. [4]

(b) Succinic acid is esterified by ethanol, $\text{C}_2\text{H}_5\text{OH}$, in the presence of an acid catalyst to form an equilibrium mixture.

The equilibrium constant, K_c , for this equilibrium can be calculated using the amounts, in moles, of the components in the equilibrium mixture, using **expression 5.1**.

$$K_c = \frac{n((\text{CH}_2\text{COOC}_2\text{H}_5)_2) \times n(\text{H}_2\text{O})^2}{n((\text{CH}_2\text{COOH})_2) \times n(\text{C}_2\text{H}_5\text{OH})^2} \quad \text{Expression 5.1}$$

A student carries out an experiment to determine the value of K_c for this equilibrium.

- The student mixes together 0.0500 mol of succinic acid and 0.150 mol of ethanol, with a small amount of an acid catalyst.
- The mixture is allowed to reach equilibrium.
- The student determines that 0.0200 mol of succinic acid are present in the equilibrium mixture.

(i) Which technique could be used to determine the equilibrium amount of succinic acid? [1]

- (ii) Write the equation for the equilibrium reaction that takes place. [1]
- (iii) Draw the skeletal formula of the ester present in the equilibrium mixture. [1]
- (iv) K_c is the equilibrium constant in terms of equilibrium concentrations.
Why can **expression 5.1** be used to calculate K_c for this equilibrium? [1]
- (v) Calculate the value of K_c for this reaction.
Show your working. [3]

Total Marks for Question Set 10: 11

OCR

Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge