Partition of butanedioic acid between water and butan-1ol

Student worksheet

Health and safety note

Wear eye protection. Butan-1-ol is harmful and flammable. 0.05 mol dm^{-3} sodium hydroxide solution is an irritant.

Principle

Butanedioic acid (old name, succinic acid) has the molecular formula $HOOCCH_2CH_2COOH$.

The distribution of butanedioic acid between water and butan-1-ol may be determined by shaking an aqueous solution of the acid with butan-1-ol, separating the two layers and determining the concentration of butanedioic acid in each layer by acid-base titration.

Equipment and materials

- 100 cm^3 separating funnels x 4
- 250 cm^3 conical flasks x 4
- 50 cm^3 burettes x 2
- 5 cm^3 pipettes with fillers x 2
- Boiling tubes x 8

- 0.02 g dm^{-3} aqueous butanedioic acid solution
- Butan-1-ol – Harmful, Flammable
- 0.05 mol dm^{-3} sodium hydroxide solution – Irritant
- Phenolphthalein indicator solution – Highly flammable, Harmful

Method

1. Measure room temperature.
2. Clamp four separating funnels using a stand, clamp and boss. Label them A, B, C and D. Measure the following volumes of liquids into them:

	0.02 g dm^{-3} aqueous butanedioic acid solution $/\text{cm}^3$	Deionised water $/\text{cm}^3$	Butan-1-ol $/\text{cm}^3$
A	20	0	15
B	15	5	15
C	10	10	15
D	5	15	15

3. Unclamp the funnels and mix the mixtures in each stoppered funnel by shaking gently for 20 minutes.
4. Clamp them again and leave while the two layers separate. The lower layer is the aqueous and the upper layer is organic.
5. Now for each separating funnel:

   a. Drain about 15 cm^3 of the lower layer (the aqueous solution) into a boiling tube and stopper it.

b. Drain the next portion into a waste bottle until the meniscus between the layers leaves the funnel followed by a further 2-3 cm^3 of the butan-1-ol layer.

c. Drain the remainder of the liquid in the funnel (the butan-1-ol layer) into a boiling tube. Stopper the tube.

d. Pipette 5.0 cm^3 of the aqueous layer into a conical flask. Titrate it against 0.05 mol dm^{-3} sodium hydroxide solution using phenolphthalein as the indicator.

e. Using another pipette, measure 5.0 cm^3 of the butan-1-ol layer into a conical flask and titrate it against 0.05 mol dm^{-3} sodium hydroxide solution using phenolphthalein.

Calculations

For each experiment, calculate:

1. the concentration of butanedioic acid in the aqueous layer;

2. the concentration of butanedioic acid in the butan-1-ol layer;

3. the distribution coefficient, D, and $\log D$ at room temperature;

4. the average of the values for the distribution coefficient of butanedioc acid between water and butan-1-ol.