

Experiment 18

To determine the partition coefficient of ethanoic acid between water and butan-2-ol.

Procedure

The room temperature was recorded.

15 cm³ of the given aqueous ethanoic acid and 15 cm³ of butan-2-ol were poured into a 100 cm³ separating funnel, using suitable apparatus. The funnel was stoppered and was shaken vigorously for 1 to 2 minutes. (The pressure in the funnel was released by occasionally opening the tap.)

10 cm³ of each layer was separated approximately. (The fraction near the junction of the two layers was discarded.)

10.0 cm³ of the aqueous layer was pipetted into a conical flask and was titrated with 0.1 M sodium hydroxide solution using phenolphthalein.

Using another pipette, 10.0 cm³ of the alcohol layer was delivered into a conical flask and was titrated with 0.1 M sodium hydroxide solution.

Steps (2) to (5) was repeated with another separating funnel using the following volume:

25 cm³ of aqueous ethanoic acid and 15 cm³ of butan-2-ol

For each experiment, the ratio of the concentration of ethanoic acid in the aqueous layer to that in the butan-2-ol layer was calculated.

Result

Room temperature: 29°C

Volume of butan-2-ol: 15 cm³

Volume of 0.2M ethanoic acid / cm ³	Volume of 0.1M NaOH titre for aqueous layer / cm ³	Volume of 0.1M NaOH titre for alcohol layer / cm ³	Partition coefficient $K = \frac{\text{conc. of acid in aq. layer}}{\text{conc. of acid in alc. layer}}$
15	10.00	12.55	0.796
25	12.10	15.60	0.776

Conclusion

The partition coefficient of ethanoic acid between water and butan-2-ol is :

$$\frac{0.796 + 0.776}{2}$$

=0.786

Discussion

Shaking is necessary in step (2) because it made it faster to attain equilibrium state. When temperature increases, the solubility of the two solvents increase. But the rate of the increase in solubility are not the same, it is expected that the partition coefficient varies with temperature.

The aim of titration is to find the concentration of the solvent, but not the total number of mole in the solvent. Therefore, the volumes of the aqueous and alcohol solution used in the titration must be known as accurately as possible in order to find accurately concentration. The aim of adding aqueous ethanoic acid and 2-methylpropan-1-ol is only to leave the mixture to equilibrium and provide enough solvent for the titration. Therefore the amounts of aqueous ethanoic acid and 2-methylpropan-1-ol need not be measured out accurately.

The following assumptions are made:

The temperature of the mixture remained constant throughout the experiment. This assumption was valid as it was felt (by hand) that the temperature of the separating funnel did not changed throughout the experiment.

Ethanoic acid, water and butan-2-ol are non-volatile and do not evaporate slowly.

This assumption is not valid because there is a smell of alcohol over the separating funnel. That means that there are particles coming out from the mixture in the separating funnel.

Solvent extraction is more efficient if the extraction solvent is added in small portions several times instead of all at once. Therefore it is more efficient to extract a solute with two 25cm³ portions of solvent rather than with a single 50cm³ extraction.

The applications of the partition law:

By partition law, the K_D can be found experimentally. The amount of the solute that can be extracted using solvent extraction can be predicted, instead of using other complex method.

By partition law, we know that the amount of solute extracted is more when the extracting solvent is added in several small portions instead of all at once.

Butan-2-ol is much lighter than water. Therefore butan-2-ol is at the top of the mixture while water is at the bottom.