EXPERIMENT 24   DETERMINATION OF PARTITION COEFFICIENT OF ACETIC ACID BETWEEN n-BUTYL ALCOHOL AND WATER

In dilute solutions at constant temperature a solute which exists in the same molecular species in two non-miscible solvents, will distribute itself between these two solvents at constant temperature according to the partition law, the partition coefficient:

$$k = C_1/C_2$$

where C_1 = concentration of acetic acid in water, and

C_2 = concentration of acetic acid in buty1 alcohol

The concentrations C_1 and C_2 must be expressed in the same units either as grams, gram molecules, or gram equivalents per litre.

Procedure:

Boil about 200 mL of distilled water in a beaker for 10 minutes. Pour into a flask and stopper lightly and cool. This is CO_2 free water for later use. In a 200 mL glass stoppered bottle place about 70 mL of approximately 2M acetic acid and 50 mL of n-butyl alcohol. Stopper the bottle and shake well for at least 1 minute, and then allow the liquid layers to separate. Note and record the temperature of the mixture.

Insert a 25 mL pipette and carefully withdraw a 25 mL aliquot of the upper alcohol layer. The pipette should first be rinsed by sucking up a little of the solution and discarding this. Pipette the solution into a second glass stoppered bottle and add an approximately equal volume of boiled distilled water to this second bottle.

Shake-well to transfer the acid to the water layer, add 3 drops of phenolphthalein and titrate with the approximately 1.0 M sodium hydroxide. The bottle should be stoppered from time to time and <u>vigorously shaken and titration</u> continued until a faint permanent pink colour remains.

Pipette, also a 25 mL aliquot from the lower aqueous layer of the first bottle as follows. Close the pipette with the finger and place it carefully in the lower layer. Suck up and blow out gently a small quantity of liquid to wash out any small quantity of the upper layer that has got into the pipette. Rinse the pipette with a little of solution. Allow the solutions to settle and withdraw 25 mL of the lower solution. Place this solution in a flask, add three drops of phenolphthalein and titrate with the approximately 1.0 M sodium hydroxide.

Add about 25 mL each of fresh butanol and boil distilled water (but no further acid) to the original mixture remaining in the first bottle. Repeat the procedure above and sample and titrate with the new concentrations of acid.

The following table summarises the above procedure:

Initial mixture: 50 mL n-butyl alcohol, 70 mL 2M acid:

Table 5   Summary of procedure

Alcohol Layer		Water Layer		Alkali for Titration mL		
Sample Removed ML	Fresh Alcohol Added	Sample Removed mL	Water Added mL	Water Alcohol C_1	C_2	$K = C_1 / C_2$
25	--	25	--			
--	25	--	25	—	—	
25	--	25	--			

As long as the same concentration of alkali is used for titrating samples of equal volume from layers in equilibrium, the partition coefficient can be found by simple division of one titre by the other (provided the solution distributes normally between the two liquids).

Record the observed partition coefficient and temperature. All solutions from titrations of the alcoholic samples and any other alcohol residues should **be placed in the residue bottles provided and not wasted by pouring down the sink**.