25. Equilibria

25.2 Partition coefficients

Paper 4

Question Paper

1 **(a)** **(i)** State what is meant by partition coefficient, K_{pc}.

.....

.....

..... [1]

(ii) The partition coefficient, K_{pc}, for a compound, **X**, between carbon disulfide, CS_2, and water is 10.5.

1.85 g of **X** is dissolved in water and made up to 100.0 cm^3 in a volumetric flask.
40.0 cm^3 of this aqueous solution is shaken with 25.0 cm^3 of CS_2.
The mixture is left to reach equilibrium.

Calculate the mass of **X**, in g, extracted into the CS_2 layer.

mass of **X** = ... g [2]

2 **(d)** The partition coefficient, K_{pc}, of a substance, **Q**, between hexane and water is 7.84 at 298 K.

Q is more soluble in hexane than it is in water.

(i) Define partition coefficient, K_{pc}.

.....

..... [1]

(ii) 5.00 g of **Q** is shaken with a mixture of 100.0 cm^3 of water and 100.0 cm^3 of hexane at 298 K and left until there is no further change in concentrations.

Calculate the mass of **Q** dissolved in the water.

mass of **Q** = ... g [1]

(iii) A sample of **Q** is shaken with a different mixture of water and hexane and left until there is no further change in concentrations.

It is found that the mass of **Q** dissolved in each solvent is the same.

Use the K_{pc} value to suggest possible values for the volume of water used and the volume of hexane used.

volume of water = ... cm^3

volume of hexane = ... cm^3
[1]

(iv) **Q** is more soluble in hexane than it is in water.

It is suggested that **Q** is one of KC*l*, $CH_3(CH_2)_4OH$ or HCOOH.

Identify **Q**. Explain your answer.

.....

..... [1]

3 Procaine is used as an anaesthetic in medicine. It can be synthesised from methylbenzene in five steps as shown in Fig. 7.1.

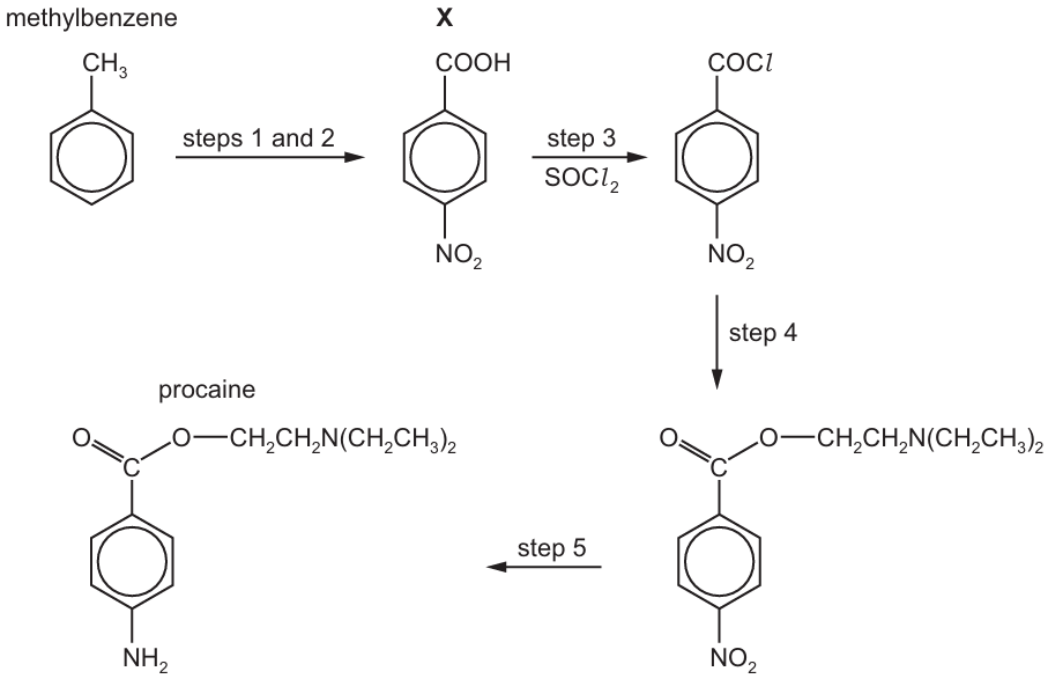

Fig. 7.1

(f) (i) Explain what is meant by partition coefficient, K_{pc}.

.....

..... [2]

(ii) The partition coefficient of procaine between octan-1-ol and water is 1.77.

Octan-1-ol and water are immiscible. A solution containing 0.500 g of procaine in 75.0 cm^3 of water is shaken with 50.0 cm^3 of octan-1-ol.

Calculate the mass of procaine that is extracted into the octan-1-ol.

mass of procaine extracted = ... g [2]

4 **(a)** A sample of butanoic acid, $CH_3(CH_2)_2COOH$, is shaken with a mixture of two immiscible solvents, ethoxyethane and water. The solvents form two layers. The butanoic acid is distributed between the two layers, its concentration in ethoxyethane being higher than its concentration in water.

(i) State what is meant by partition coefficient.

.....

..... [1]

(ii) The partition coefficient, K_{pc}, for butanoic acid between ethoxyethane and water is 3.50.

A solution of 2.00 g of butanoic acid in 100 cm^3 ethoxyethane is added to water. This mixture is left until there is no further change in the concentration of butanoic acid in either solvent. The mass of butanoic acid dissolved in the ethoxyethane layer is now 1.62 g.

Calculate the volume of water used.

volume of water used = ... cm^3 [2]

5 Ethoxyethane, $C_2H_5OC_2H_5$, can dissolve both in water and in octan-1-ol. The expression and numerical value for the partition coefficient of ethoxyethane between water and octan-1-ol are given. Water and octan-1-ol are immiscible.

$$K_{pc} = \frac{\text{concentration of } C_2H_5OC_2H_5 \text{ in octan-1-ol}}{\text{concentration of } C_2H_5OC_2H_5 \text{ in water}} = 6.760 \text{ at } 20\,^{\circ}C$$

(a) In an experiment, octan-1-ol at 20 °C is added to a solution of ethoxyethane in water at 20 °C. The mixture is analysed immediately and a value of K_{pc} is calculated.

The calculation is performed correctly; the value calculated is 5.625.

Explain why the value calculated is **less** than 6.760.

.....

..... [2]

(b) A second experiment is performed and the value of K_{pc} is found to be 6.760. The concentration of ethoxyethane in the octan-1-ol layer is 7.62 g dm^{-3}.

(i) Calculate the concentration, in g dm^{-3}, of ethoxyethane in the aqueous layer.

..... g dm^{-3} [1]

(ii) 100 cm^3 of the octan-1-ol layer is taken and shaken with 100 cm^3 of water.

Calculate the maximum amount, in mol, of ethoxyethane that can be extracted into the water.

..... mol [3]

6 **(a)** Define the term *partition coefficient,* K_{pc}.

.....

.....

..... [2]

(b) K_{pc} of benzoic acid between octan-1-ol and water is 79.4.

(i) A solution of 0.400 g of benzoic acid in 25.0 cm^3 octan-1-ol is shaken with 125 cm^3 of water.

Calculate the mass of benzoic acid extracted into the water layer.

mass of benzoic acid extracted = ... g [2]

(ii) K_{pc} of benzophenone, $C_6H_5COC_6H_5$, between octan-1-ol and water is different from the value of K_{pc} of benzoic acid given in **(b)(i)**.

Explain why.

.....

.....

..... [1]

7 **(c)** Water and octan-1-ol form two layers when mixed.

Ethanamide is more soluble in water than it is in octan-1-ol. When 1.00 g of ethanamide is added to 50.0 cm^3 of water and this is then shaken with 50.0 cm^3 of octan-1-ol, it is found that the water layer contains 0.935 g of ethanamide at equilibrium.

(i) Calculate the partition coefficient, K_{pc}, for ethanamide in water and octan-1-ol.

K_{pc} = ... [1]

(ii) The 50.0 cm^3 of water containing 0.935 g of ethanamide is then shaken with 100.0 cm^3 of pure octan-1-ol under the same conditions.

Calculate the mass of ethanamide that is dissolved in the 100.0 cm^3 of octan-1-ol at equilibrium.

mass of ethanamide = ... g
[2]