

25.2 PARTITION COEFFICIENTS- CONTENTS

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Introduction

1. State what is meant by partition coefficient, K_{pc} .

.....
.....
..... [1]

2. 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 cm³ of water, and this is then shaken with 50.0 cm³ of octan-1-ol, it is found that the water layer contains 0.935 g of ethanamide at equilibrium.
Calculate the partition coefficient, K_{pc} , for ethanamide in water and octan-1-ol.

K_{pc} = [1]

- (ii) The 50.0 cm³ of water containing 0.935 g of ethanamide is then shaken with 100.0 cm³ of pure octan-1-ol under the same conditions.
Calculate the mass of ethanamide that is dissolved in the 100.0 cm³ of octan-1-ol at equilibrium.

mass of ethanamide = g [2]

3. A sample of butanoic acid, $\text{CH}_3(\text{CH}_2)_2\text{COOH}$, 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, with its concentration in ethoxyethane being higher than its concentration in water. 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 =(ans = 82)..... cm^3 [2]

4. 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]

5. Ammonia is soluble in both water and organic solvents.
 An aqueous solution of ammonia is shaken with the immiscible organic solvent trichloromethane. The mixture is left to reach equilibrium.
 Samples are taken from each layer and titrated with dilute hydrochloric acid.
 A 25.0 cm³ sample from the trichloromethane layer requires 13.0 cm³ of 0.100 mol dm⁻³ HCl to reach the end-point.
 A 10.0 cm³ sample from the aqueous layer requires 12.5 cm³ of 0.100 mol dm⁻³ HCl to reach the end-point.

(i) Calculate the partition coefficient, K_{pc} , of ammonia between trichloromethane and water.
 Show your working.

$$K_{pc} = \dots\dots\dots [2]$$

(ii) Butylamine, C₄H₉NH₂, is also soluble in both water and organic solvents.
 Suggest how the numerical value of K_{pc} of butylamine between trichloromethane and water would compare to the value of K_{pc} calculated in (i). Explain your answer.

.....

 [2]

6. 80.0 cm³ of an aqueous solution containing 0.704 g of CH₃CH₂CH₂COOH is shaken with 100 cm³ of benzene, C₆H₆.
 There is 0.556 g of CH₃CH₂CH₂COOH in the 100 cm³ of C₆H₆ at equilibrium.
 Calculate the partition coefficient, K_{pc} , of CH₃CH₂CH₂COOH between C₆H₆ and water.
 Show your working.

$$K_{pc} = \dots\dots\dots [2]$$

7. 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) 5.00 g of Q is shaken with a mixture of 100.0 cm³ of water and 100.0 cm³ 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]

(ii) 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 = cm³

volume of hexane = cm³

[1]

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

It is suggested that Q is one of KCl, CH₃(CH₂)₄OH or HCOOH.

Identify Q. Explain your answer.

.....

..... [1]

8. Ethoxyethane, C₂H₅OC₂H₅, 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} = concentration of C₂H₅OC₂H₅ in octan-1-ol = 6.760 at 20 ° C

concentration of C₂H₅OC₂H₅ in water

(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]

9. (i) Explain what is meant by the 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]

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