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THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. Degree Programme
Level 5 –Continuous Assessment Test II– 2023/24
CYU 5302 – Analytical Chemistry

Duration: One hour
Date: 18th August, 2023
Time: 9.00 a.m. to 10.00 a.m.

Reg. No..

Question number	Max. marks	marks
1	33	
2	26	
3	41	
Total	100	

Instructions to students

Answer all questions in the spaces given. Additional sheets will not be marked.

1. The distribution coefficient and the distribution ratio of the weak acid HA between diethyl ether and water is 24 and 20 respectfully. A 100 mL water sample having HA was extracted with 100 mL of ether at pH 3.00.

    (i)   What is the difference between distribution coefficient and distribution ratio?

    (10 marks)

    (ii)   After the equilibration, the concentration of HA remaining in the aqueous layer was 0.02 M. Calculate the initial total number of moles of HA that was present in the aqueous layer.

    (13 marks)

    (iii)   Suggest one way of increasing the extracted amount using the same volume of ether.

    (10 marks)

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2. (i) State the mechanism behind separation and the stationary phase of paper chromatography? (10 marks)

Mechanism=   stationary phase=

   (ii) A mixture was having the compounds P,Q and R of which polarity decreases in the following manner: .P > R > Q. This mixture was run on a Thin Layer Chromatographic (TLC) plate under normal phase. What is the compound that has the lowest R_f value? Justify your answer. (16 marks)

3. (i) Sketch and label the conductometric titration curve for the titration of 25.0 mL of 0.1 M formic acid with 0.1 M NaOH. (12 marks)

   (ii) Draw and label a schematic diagram of a UV- Visible spectrophotometer. (10 marks)

(iii)   The absorbance measured of 4.0 ppm of Z^+ solution was 0.60 using 1 cm cell. What would be the concentration of Z^+ in the sample which gave an absorbance of 0.45 under the same conditions? (10 marks)

(iv)   Give three major advantages in potentiometric titrations compared to classical redox titrations. (09 marks)

Name:..

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1. (i)   Distribution coefficient is approximately equal to the ratio of the solubility of one solute species in the two solvents.

$$K_d = \frac{{}^a S_{(org)}}{{}^a S_{(aq)}} = \frac{[S_{(org)}]}{[S_{(aq)}]}$$

Distribution ratio is defined as the ratio of the analytical concentration of solute S (all species), in two immiscible solvents.

$$D = \frac{C_{HA(org)}}{C_{HA(aq)}}$$

(ii) Since information is given only of one species, you have consider K_d and not D.

$K_d = [HA]_{org}/[HA]_{aq}$

Substitute- $K_d = 24$ $[HA]_{aq} = 0.0.02$ M

$[HA]_{org} = 24 \times 0.02 = 0.48$ M

The total concentration $= 0.02 + 0.48 = 0.5$ M

No. of moles of HA that was present initially in the aqueous layer

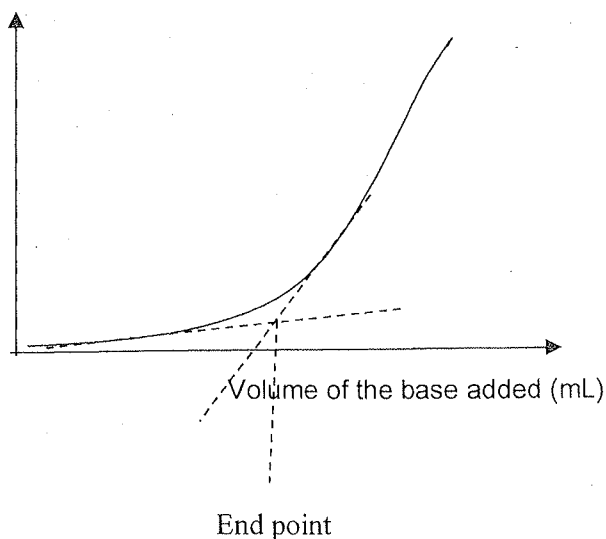$= 0.5 \times 10^{-3} \times 10^{-2}$

$= 0.05$

(iii)   Use several portions of ether totalling up to 100 mL.

Or decrease pH

2. (i) Mechanism- partition   stationary phase- water

(ii) Normal phase: stationary phase- polar,   mobile phase- nonpolar

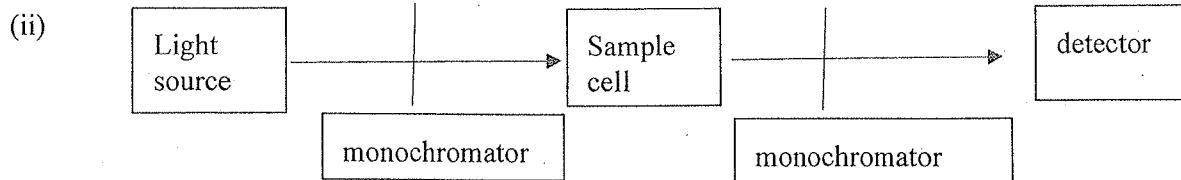R_f = $\dfrac{\text{distance travelled by the solute}}{\text{distance travelled by the solvent}}$

Low R_f means distance travelled is low. The most polar compound has the most attraction to the polar stationary phase thus less travelled. Therefore, the lowest R_f is with P.

3. (i)

Conductance (S)

Volume of the base added (mL)

End point

No marks without correct axes

(ii)

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┌──────────┐              ┌──────────┐              ┌──────────┐
│ Light    │──────┼──────▶│ Sample   │──────┼──────▶│ detector │
│ source   │      │       │ cell     │      │       │          │
└──────────┘      │       └──────────┘      │       └──────────┘
            ┌─────┴──────┐           ┌───────┴──────┐
            │monochromator│          │monochromator │
            └────────────┘           └──────────────┘
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(iii) $A = \in l\, c$

Substitute: A= 0.60   c= 4 ppm --- Eq. 1
Substitute: A= 0.45   ----------------- Eq. 2
Eq 1/ Eq. 2 = 3 ppm

(iv) 1. More accurate.
   2. no need to have an indicator
   3. can be applied for coloured/turbid solutions.
   4. can be applied for titrations with 0.2-0.4 V potential change at the end point.
   5. more sensitive