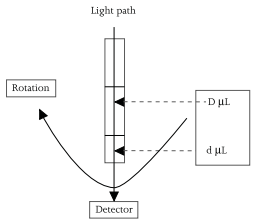
Deacon's Challenge No. 25 Answer

A centrifugal analyser is designed so that the light travels on a longitudinal path through the rotating cuvette (which has a constant cross-section C cm^2) rather than perpendicularly through the sides of the cuvette as is more usual. A solution of a light absorbing compound Y, volume d µL at a concentration of y mmol/L, is diluted with a volume D µL of an optically clear reagent.



Using the Beer-Lambert equation, prove that the absorbance of light through the diluted solution of Y is independent of the volume of diluent (D) when absorbance is measured longitudinally in this system.

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The Beer-Lambert equation is:

$$A = \varepsilon \times l \times c$$

Where A = absorbance
ε = molar absorbtivity
l = path length
c = molar concentration

Volume of cuvette = Cross sectional area x path length (i)

Where C = Crossectional area (cm^2)
l = Depth of solution in cuvette (cm)
$(D + d)$ = volume of cuvette (µL)

Since 1000 µL = 1 cm^3, $\frac{(D + d)}{1000}$ = volume of cuvette (cm^3)

Substitute these values into equation (i) and rearrange to give an expression for l in terms of D, d and C:

$$\frac{(D + d)}{1000} = C \times l$$

$$l = \frac{(D + d)}{1000C}$$

Calculate the concentration of Y in the cuvette:

$$\text{Concn in cuvette (mmol/L)} = \frac{\text{initial conc (y mmol/L) x Vol of Y (d L)}}{\text{Final vol (D + d) L}}$$

$$= \frac{(y \times d)}{(D + d)}$$

Substitute these derived values for path length (l) and final concn of X into the Beer-Lambert equation:

$$A = \varepsilon \times \frac{(D + d)}{1000C} \times \frac{(y \times d)}{(D + d)}$$

Cancelling the (D + d) terms which appear on both the top and bottom of the equation eliminates the D term:

$$A = \frac{\varepsilon \times y \times d}{1000C}$$

Thereforer the absorbance is independent of the volume of diluent (D). ■

Question No. 26

A urine collection was handed in by a patient which he said he had collected over the previous day. Calculate the creatinine clearance given that the sample was found to have a creatinine concentration of 7.2 mmol/L in a volume of 3.2 L. The serum creatinine concentration taken during the collection was 94 µmol/L. Give the most likely cause for this result.

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