Deacon's Challenge

No 187 - Answer

A solution contains 250 mg NADH disodium salt (formula $C_{21}H_{27}N_7O_{14}P_2Na_2$) per Litre. A 1 in 5 dilution transmits 36% of incident light at 340 nm (versus an appropriate blank) in a cell with 1 cm path length.

a) Calculate the molar absorptivity of NADH.
b) How much of the original solution will be needed to prepare 1 L of a solution with an absorbance at 340 nm of 0.5 when measured in a cell with a path length of 0.5 cm?

The Beer-Lambert equation relates concentration to absorbance:

$$A = a \times b \times c$$

where A = absorbance $= \log_{10} \frac{100}{\%T} = \log_{10} \frac{100}{36} = \log_{10} 2.778 = 0.444$

a = molar absorptivity = unknown

b = light path = 1.0 cm

c = concentration = 1 in 5 dilution of 250 mg/L = 50 mg/L = 0.050 g/L

Convert to mol/L since molar absorptivity is required:

First calculate MW of NADH:

C_{21}	=	12 x 21	=	252
H_{27}	=	1 x 27	=	27
N_7	=	14 x 7	=	98
O_{14}	=	16 x 14	=	224
P_2	=	31 x 2	=	62
Na_2	=	23 x 2	=	46
Total	=			709

Concentration (mol/L) = $\frac{\text{Concentration (g/L)}}{\text{MW}} = \frac{0.050}{709} = 0.0000705$ mol/L

a) Substitute these values and solve for a:

$$0.444 = a \times 1 \times 0.0000705$$

$$a = \frac{0.444}{0.0000705 \times 1} = 6298 \text{ L.mol}^{-1}.\text{cm}^{-1}$$

or **6.3×10^3 L.mol^{-1}.cm^{-1}** (to 2 sig figs since %T only given to 2 figs)

b) Use the Beer Lambert equation to calculate the final concentration which will give an absorbance of 0.5 in a cell with a path length of 0.5 cm:

$A = 0.5$ $a = 6.3 \times 10^3$ L.mol^{-1}.cm^{-1} $b = 0.5$ cm c = unknown (mol/L)

$$0.5 = 6.3 \times 10^3 \times 0.5 \times c$$

$$c = \frac{0.5}{6.3 \times 10^3 \times 0.5} = 0.000159 \text{ mol/L}$$

Volume required = $\frac{\text{Required concentration} \times \text{Required volume}}{\text{Stock concentration}}$

Stock concentration = 5 x 0.0000705 = 0.0003525 mol/L (since it was diluted 1 in 5)

Therefore volume required = $\frac{0.000159 \times 1000}{0.0003525}$

= **450 mL** (to 2 sig figs)

Question 188

The table shows data for two urinary screening tests for the detection of phaeochromocytoma:

Test	Sensitivity (%)	Specificity (%)
VMA	96.7	99.1
Total metanephrines	100	98

The prevalence of phaeochromocytoma in a hypertensive population is known to be 0.5%.

For a hypertensive individual calculate the probability of phaeochromocytoma being present:

a) Before either test is performed
b) If the VMA test is positive
c) If the total metanephrine test is positive