Exercise walk-through

Beer-Lambert Law ▪ 3.13

eXercise

You must be able to

- use $A = \varepsilon bc$ (**absorbance** 吸光度)
- interpret a calibration plot of A vs concentration
- find an unknown concentration from absorbance

Method — The Beer-Lambert law

$$A = \varepsilon b c,$$

where A is absorbance, ε the molar absorptivity, b the path length, and c the concentration. Absorbance is **proportional to concentration** (fixed ε and b).

Method — A worked value

If $\varepsilon = 200$ L mol^{-1}cm^{-1}, $b = 1.0$ cm, $c = 0.0020$ M:

$$A = (200)(1.0)(0.0020) = 0.40.$$

Method — The calibration line

Plot A (y) against concentration (x): a straight line through the origin with slope εb. Read an unknown concentration by finding its absorbance on the line.

Method — Finding an unknown

If a sample has $A = 0.30$ and the calibration line is $A = 150\,c$, then $c = \dfrac{0.30}{150} = 0.0020$ M.

Practice 2.1 ▪ 2 marks

Write the Beer-Lambert law and name each symbol.

Solution 2.1

Method: The Beer-Lambert law

Worked steps

$A = \varepsilon bc$: A absorbance, ε molar absorptivity, b path length, c concentration **B1** **B1**

equation, symbols.

Practice 2.2 ▪ 2 marks

Find A for $\varepsilon = 500$, $b = 1.0$ cm, $c = 0.0010$ M.

Solution 2.2

Method: A worked value

Worked steps

$A = (500)(1.0)(0.0010) = 0.50$ M1 A1.

Practice 2.3 ▪ 1 mark

Absorbance is proportional to which quantity?

Solution 2.3

Method: The Beer-Lambert law

Worked steps

Concentration B1.

Exam-style 3.1 ▪ 1 mark

In $A = \varepsilon b c$, doubling the concentration c (with ε, b fixed)

A halves A

B doubles A

C leaves A unchanged

D squares A

Solution 3.1

Method: The Beer-Lambert law

A halves A

B doubles A ✓

C leaves A unchanged

D squares A

Worked steps

B — A is proportional to c, so doubling c doubles A.

Exam-style 3.2 ▪ 2 marks

A calibration line for a dye is $A = 250\,c$ (with c in mol/L).
(a) Find the absorbance of a 0.0016 M solution.
(b) A sample gives $A = 0.50$. Find its concentration.

Solution 3.2

Worked steps

(a) $A = 250(0.0016) = 0.40$ M1 A1. (b) $c = \dfrac{0.50}{250} = 0.0020$ M M1 A1.

Exam-style 3.3 ▪ 3 marks

A solution's absorbance is measured as 0.80 with $\varepsilon = 400$ L mol^{-1}cm^{-1} and $b = 1.0$ cm. Find the concentration.

Solution 3.3

Worked steps

$$c = \frac{A}{\varepsilon b} = \frac{0.80}{(400)(1.0)} \quad \text{M1}\ \text{M1} \quad = 0.0020\ \text{M} \quad \text{A1}.$$