AP CHEMISTRY • EXERCISE SHEET

3.13 The Beer-Lambert Law

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

Objective

Build the skills to answer exam questions on the **Beer-Lambert law** —linking absorbance to concentration.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

The Beer-Lambert law

$$A = \varepsilon bc,$$

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).

A worked value

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

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

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.

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.

2 Practice

Now apply the methods above.

2.1 Write the Beer-Lambert law and name each symbol. [2]

2.2 Find A for $\varepsilon = 500$, $b = 1.0$ cm, $c = 0.0010$ M. [2]

2.3 Absorbance is proportional to which quantity? [1]

3 Exam-style questions

3.1 In $A = \varepsilon bc$, doubling the concentration c (with ε, b fixed) [1]

- **A** halves A
- **B** doubles A
- **C** leaves A unchanged
- **D** squares A

3.2 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. [2]

(b) A sample gives $A = 0.50$. Find its concentration. [2]

3.3 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. [3]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **3.13 The Beer-Lambert Law** lesson on the **Learn** page;
- read the **The Beer-Lambert Law** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 $A = \varepsilon b c$: A absorbance, ε molar absorptivity, b path length, c concentration.

2.2 $A = (500)(1.0)(0.0010) = 0.50$.

2.3 Concentration.

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

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

3.3 $c = \dfrac{A}{\varepsilon b} = \dfrac{0.80}{(400)(1.0)} = 0.0020$ M.