

Spectrophotometry and Beer's Law

Absorbance, Beer's law and calibration curves

Name _____ Class _____ Date _____

EQUATIONS AND DATA

$$T = I \div I_0 \cdot \%T = T \times 100 \% \cdot A = -\log T \cdot \%T = 10^{(-A)} \times 100 \%$$

$$\text{Beer's law: } A = \epsilon bc \text{ (}\epsilon \text{ in L mol}^{-1} \text{ cm}^{-1}, b \text{ in cm, c in mol/L)}$$

$$\text{Mean and sample standard deviation } (n - 1) \cdot \text{RSD} = s \div \text{mean} \times 100 \% \cdot \text{Cu} = 63.55 \text{ g/mol}$$

Absorbance and transmittance have no units; show units on every other quantity.

A. Understanding

1. (a) Define transmittance and absorbance. (b) Why are measurements made at λ_{max} ? (c) What is a blank, and why is it needed?

B. Absorbance and transmittance

2. Find the absorbance for: (a) $T = 0.500$ (b) $T = 0.100$ (c) $35.0 \%T$. Find the $\%T$ for: (d) $A = 0.200$ (e) $A = 1.00$

C. Beer's law

3. A solution in a 1.00 cm cell has $A = 0.725$. The molar absorptivity is $1.45 \times 10^4 \text{ L mol}^{-1} \text{ cm}^{-1}$. Find the concentration.

4. A $2.50 \times 10^{-5} \text{ mol/L}$ solution gives $A = 0.360$ in a 1.00 cm cell. Calculate the molar absorptivity, with its units.

5. For the solution in question 4, predict the absorbance (a) in a 2.00 cm cell (b) at half the concentration in a 1.00 cm cell. Explain using Beer's law.

6. An unknown gives $A = 1.85$, which is above the calibration range. 10.00 mL of it is diluted to 50.00 mL, and the diluted solution gives $A = 0.370$ in a 1.00 cm cell ($\epsilon = 1.20 \times 10^4 \text{ L mol}^{-1} \text{ cm}^{-1}$). Find the concentration of (a) the diluted solution (b) the original unknown.

D. Calibration and replicates

7. A set of standards gives the best-fit line $A = (0.0820 \text{ L/mg}) c + 0.003$. An unknown is measured in triplicate: $A = 0.334, 0.338, 0.331$. (a) Find the mean absorbance, the standard deviation and the RSD. (b) Find the concentration of the unknown.

8. Explain (a) why the unknown in question 7 is measured three times instead of once (b) why the unknown should lie inside the range of the standards (c) what a large intercept on the calibration line might show.

E. Challenge

9. 0.1000 g of brass is dissolved in acid, the copper is converted into a coloured complex, and the solution is diluted to exactly 1.000 L. It gives $A = 0.409$ in a 1.00 cm cell, and ϵ of the complex is $395.0 \text{ L mol}^{-1} \text{ cm}^{-1}$. Calculate the percentage by mass of copper in the brass.