

Concentration, separation and absorbance

AP Chemistry · Worksheet

Name: _____ Date: _____ Class: _____

These problems train molarity and dilution calculations, interpretation of chromatograms and calibration graphs, and use of the Beer-Lambert law. They follow AP Chemistry unit 3 and the quantitative and experimental skills of the free-response section.

The first problems use one step. Later problems combine dilution with spectrophotometry or ask you to design a method. In the last five, explain each choice in sentences and give units throughout.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 3

Problem 1 Molarity of salt solution (easy)

Kofi in Accra dissolves 11.7 g of NaCl (58.44 g/mol) and makes the solution up to 500.0 mL. Calculate the molarity.

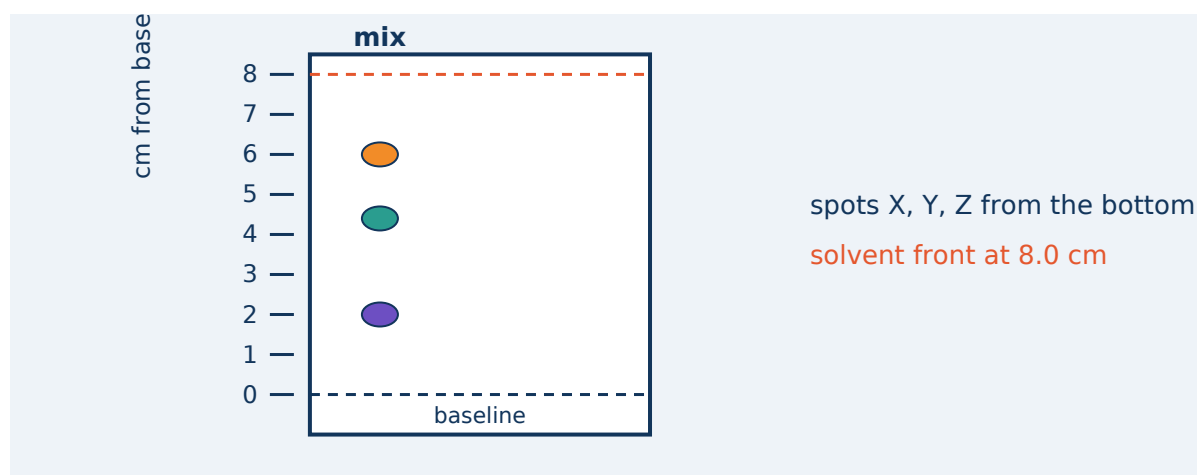
Problem 2 Mass for a solution (easy)

Calculate the mass of KCl (74.55 g/mol) needed to make 250.0 mL of 0.100 M solution.

Problem 3 Simple dilution (easy)

A 25.0 mL sample of 1.00 M stock is diluted to a total of 250.0 mL. Calculate the new concentration.

Problem 4 Calculate R_f values (easy)



Chromatogram of a food-colouring mixture.

A chromatogram shows three spots X, Y and Z.

1. Read the distance moved by each spot and by the solvent front.
2. Calculate R_f for each spot.
3. State which spot is most strongly held by the stationary phase.

Problem 5 Transmittance and absorbance (easy)

1. Calculate the absorbance of a solution that transmits 50 percent of the light.
2. Calculate the percentage transmittance when $A = 1.000$.

Problem 6 Choose a separation method (easy)

Name the best method to separate each: (1) sand from salt water, (2) pure water from salt water, (3) the dyes in a black pen ink, (4) ethanol from a water-ethanol mixture.

Problem 7 Ion concentrations (medium)

Calculate the concentration of each ion in (1) 0.30 M CaCl_2 and (2) 0.20 M $\text{Al}_2(\text{SO}_4)_3$.

Problem 8 Lead in drinking water (medium)

A 1.50 L sample of tap water in a Nairobi school contains 0.0210 mg of lead.

1. Calculate the concentration in mg/L (ppm).
2. Convert this to $\mu\text{g/L}$ (ppb).

Problem 9 Make a copper sulfate solution (medium)

Describe how you would make 100.0 mL of 0.250 M CuSO_4 from the hydrated solid $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (249.70 g/mol), and calculate the mass needed.

Problem 10 A dilution series (medium)

Mei in Singapore needs 50.0 mL each of 0.100 M, 0.0500 M, 0.0250 M and 0.0100 M solutions from a 0.500 M stock. Calculate the volume of stock for each.

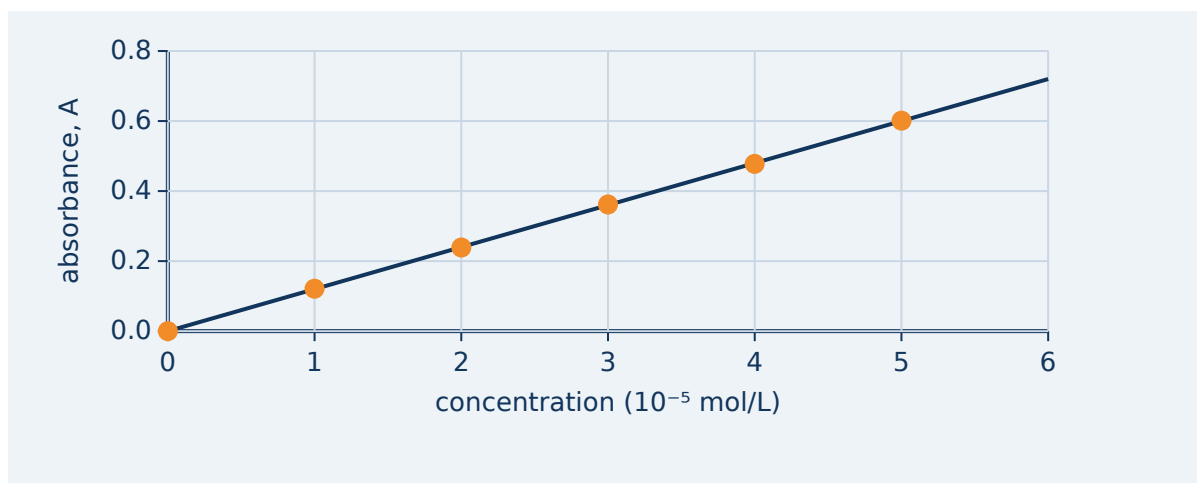
Problem 11 Find a concentration with Beer-Lambert (medium)

A solution has $A = 0.450$ at λ_{max} in a 1.00 cm cuvette. Its molar absorptivity is $\epsilon = 9.0 \times 10^3 \text{ L}/(\text{mol} \cdot \text{cm})$. Calculate the concentration.

Problem 12 Change the path length (medium)

A solution has $A = 0.300$ in a 1.00 cm cuvette.

1. Predict A in a 2.00 cm and in a 0.50 cm cuvette.
2. Calculate the percentage transmittance for the 1.00 cm cuvette.

Problem 13 Use a calibration graph (medium)


Calibration line for a blue dye, measured in a 1.00 cm cuvette.

1. A sample of the dye gives $A = 0.360$. Read its concentration.
2. Calculate the gradient of the line and the molar absorptivity ϵ .
3. Explain why the line passes through the origin.

Problem 14 Why chromatography separates (medium)

Wanjiru in Nairobi runs a mixture of a polar dye and a nonpolar dye on a silica TLC plate with a nonpolar solvent. Predict which dye has the larger R_f and explain.

Problem 15 Mixing two solutions (medium)

Mix 50.0 mL of 0.200 M NaCl with 150.0 mL of 0.100 M NaCl. Assume the volumes add. Calculate the final concentration.

Problem 16 Volume for a titration-style reaction (hard)

Silver nitrate reacts with chloride: $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$. Calculate the volume of 0.150 M AgNO_3 needed to precipitate all the chloride in 25.0 mL of 0.100 M NaCl.

Problem 17 When Beer's law fails (hard)

Chiamaka in Lagos measures a dye series (1.00 cm cuvette):

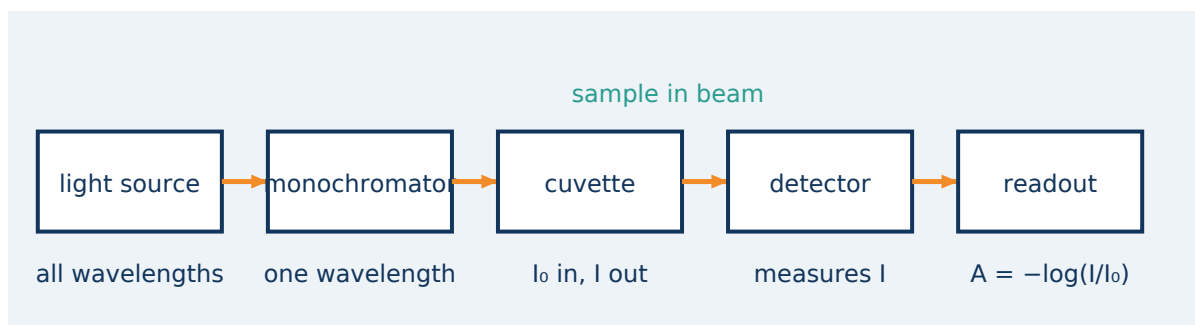
c (10^{-5} mol/L)	1	2	4	8	16	32
A	0.12	0.24	0.48	0.95	1.80	2.60

1. Calculate A/c for each standard.
2. Identify the range where Beer's law holds.
3. A sample reads $A = 2.30$. Explain what to do.

Problem 18 Absorbance from percent transmittance (hard)

A solution transmits 18.0 percent of the light in a 1.00 cm cuvette. Its ϵ is 1.5×10^4 L/(mol·cm). Calculate its absorbance and concentration.

Problem 19 Diluted sample (hard)



Parts of a spectrophotometer.

A sample of dye is diluted by transferring 10.00 mL to a 100.0 mL flask. The diluted solution gives $A = 0.480$ in a 1.00 cm cuvette ($\epsilon = 1.20 \times 10^4$ L/(mol·cm)).

1. Calculate the concentration of the diluted solution.
2. Calculate the concentration of the original sample.
3. Explain the role of the monochromator.

Problem 20 Design a colorimetric analysis (hard)

Diego in Texas wants to find the concentration of copper(II) ions in a blue solution using a spectrophotometer. Design the procedure, state how to choose the wavelength and what graph to plot, and state one source of error.