ANSWER KEY. Accept answers that are close when values are read from a graph.

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Beer's Law

Honors Chemistry | ANSWER KEY

Show your work with units and the correct number of significant figures. **Beer's Law:** A = εLc, where A is absorbance, ε is the absorption coefficient ($M^{-1}cm^{-1}$), L is the path length (cm), and c is concentration (M).

Part A: Concepts

1. Define **transmittance** and **absorbance**. When the absorbance of a sample goes up, what happens to its transmittance?

Transmittance (%T) is the percent of light that passes through the sample. Absorbance (A) is how much light the sample absorbs. When absorbance goes up, transmittance goes down.

2. Why must you "blank" the spectrophotometer before measuring samples? What goes in the blank cuvette?

The cuvette and the solvent absorb a little light too. Blanking with a cuvette of solvent only (distilled water) sets A = 0 (100% T), so later readings measure only the light absorbed by the solute.

Part B: Calculations

3. A copper(II) sulfate solution in a 1.00 cm cuvette has an absorbance of 0.506 at 635 nm. The absorption coefficient of $CuSO_4$ at this wavelength is 2.81 $M^{-1}cm^{-1}$. What is the concentration of the solution?

$c = A \div (\varepsilon L) = 0.506 \div (2.81\ M^{-1}cm^{-1} \times 1.00\ cm) =$ <u>$0.180\ M$</u>

4. A 0.150 M solution has an absorbance of 0.420. Using the same cuvette and wavelength, a second solution of the same substance has an absorbance of 0.700. What is the concentration of the second solution?

A is directly proportional to c, so A ÷ c stays the same: $0.420 \div 0.150\ M = 2.80\ M^{-1}$. $c = 0.700 \div 2.80\ M^{-1} =$ <u>$0.250\ M$</u> (or $0.150\ M \times 0.700 \div 0.420 = 0.250\ M$)

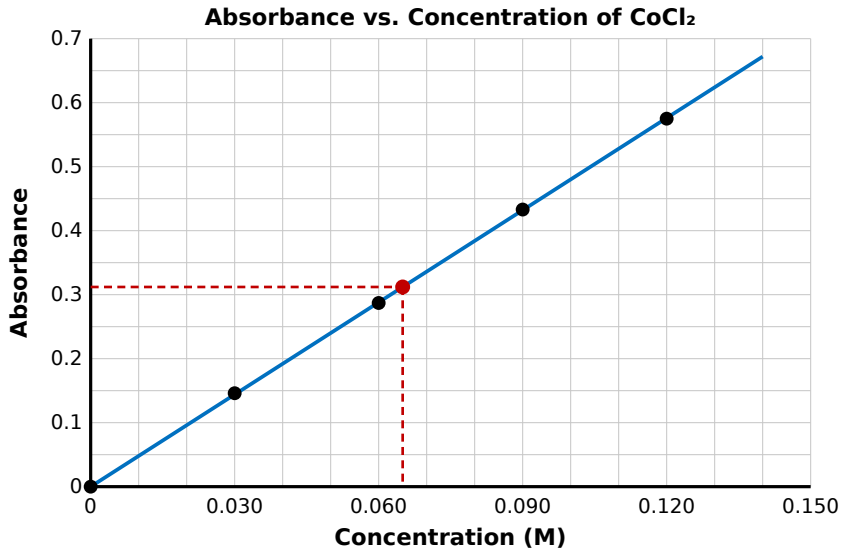
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Part C: Standard Curve

A student ran the cobalt chloride lab at 500 nm using 1.00 cm cuvettes and collected the data below.

5. Plot the data on the grid. Title the graph, label both axes with units, use an appropriate scale, and draw a best-fit line.

Concentration (M)	Absorbance
0.000 (blank)	0.000
0.030	0.146
0.060	0.287
0.090	0.433
0.120	0.575
Unknown	0.312



6. Calculate the slope of your best-fit line. Include units.

Using two points on the line, (0, 0) and (0.120 M, 0.576): slope = (0.576 − 0) ÷ (0.120 M − 0) = <u>4.80 M^{-1}</u> (accept about 4.7 to 4.9 M^{-1}; the slope equals εL).

7. Use your slope and the absorbance of the unknown to calculate its concentration. Include units and the correct number of significant figures.

c = A ÷ slope = 0.312 ÷ 4.80 M^{-1} = <u>0.0650 M</u> (about 0.064 to 0.066 M, depending on the slope)

8. Describe the trend in the data and explain the relationship between absorbance and concentration.

Absorbance increases as concentration increases, in a straight line through the origin. They are directly proportional: doubling c doubles A because twice as many particles are in the light path to absorb light.

9. A student rinses the unknown's cuvette with distilled water but leaves drops of water inside before adding the unknown. How does this affect the measured absorbance and the calculated concentration? Justify your answer.

The water dilutes the unknown, so fewer $CoCl_2$ particles are in the light path. The measured absorbance is <u>too low</u>, so the calculated concentration is also <u>too low</u>.

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