PS 190 — ANSWERS

1. a) \(100\% - (36.80\%/T) = 63.20\% \text{ absorption}\)
   \[A = \log \left(\frac{100\%}{36.80\%/T}\right) = 0.4342 = \text{ absorbance}\] 
   \(\text{ (four sig. figs.)}\)

b) \(100\% - (10.00\%/T) = 90.00\% \text{ absorption}\)
   \[A = \log \left(\frac{100\%}{10.00\%/T}\right) = 1.0000 = \text{ absorbance}\] 
   \(\text{ (four sig. figs.)}\)

c) \(100\% - (1.00\%/T) = 99.00\% \text{ absorption}\)
   \[A = \log \frac{100\%}{1.00\%/T} = 2.00 = \text{ absorbance}\] 
   \(\text{ (three sig. figs.)}\)

d) \(100\% - (0.01\%/T) = 99.99\% \text{ absorption}\)
   \[A = \log \frac{100\%}{99.99\%/T} = 0.0000 = \text{ absorbance}\] 
   \(\text{ (four sig. figs.)}\)

Note: Since absorbance is a logarithmic value, its sig figs are the digits to the right of the decimal point.

2. a) \(A = 0.707\); antilog \(A = 5.09 = \left(\frac{100\%}{x/\%T}\right); x = \frac{100\%}{5.09} = 19.6\%T\)

b) \(A = 0.4343\); antilog \(A = 2.718 = \frac{100\%}{x}\); \(x = \frac{100\%}{2.718} = 36.79\%T\)

c) \(A = 3.000\); antilog \(A = 100.0 = \frac{100\%}{x}\); \(x = \frac{100\%}{100.0} = 0.100\%T\)

d) \(A = 0.1000\); antilog \(A = 1.259 = \frac{100\%}{x}\); \(x = \frac{100\%}{1.259} = 79.43\%T\)

e) \(A = 0.01000\); antilog \(A = 1.0233 = \frac{100\%}{x}\); \(x = \frac{100\%}{1.0233} = 97.724\%T\)

3. \(37.5\%T \text{ at } 8.43 \text{ ppm} \Rightarrow A = \log \frac{100\%}{37.5\%/T} = 0.426 = k(8.43 \text{ ppm})\)

   \(\text{\textbf{. The proportionality constant for the cell, } k = \frac{0.426}{8.43} = 0.0505.}\)

   \(33.6\%T \text{ at Unknown ppm} \Rightarrow A = \log \frac{100\%}{33.6\%/T} = 0.474 = k(\text{Unk ppm})\)

   \(\text{\textbf{. The concentration of the Unknown } = \frac{0.474}{k} = \frac{0.474}{0.0505} = 9.38 \text{ ppm}.}\)
4. DATA given:

500.0 mg Impure X \(\Rightarrow\) 500.0 mL \(;\) 12.59 \%T in a 1.00 cm cell

10.00 mg Pure X \(\Rightarrow\) 1000.0 mL \(;\) 50.12 \%T in a 0.100 cm cell

Since the path length isn't the same in the two cells, use \(A = kbc\).

CALCULATIONS:

For the Pure X

\[ \text{50.12 \%T} \Rightarrow A = \log \left( \frac{100\%}{50.12\%T} \right) = 0.3000 = k(0.100 \text{ cm})(\frac{10.00 \text{ mg X}}{1000.0 \text{ mL}}) \]

Solving for \(k\):

\[ k = \frac{0.300 \times 1000}{0.100 \times 10.00} = 300 \text{ (three sig figs)} \]

This \(k\) value also applies to the measurement on the Impure X, if the same dimensional units are used for each factor.

For the Impure X

\[ \text{12.59 \%T} \Rightarrow A = \log \left( \frac{100\%}{12.59\%T} \right) = 0.9000 = k(1.00 \text{ cm})(\frac{\text{mg Impure X}}{500.0 \text{ mL}}) \]

Solving for mg Impure X:

\[ \text{mg Impure X} = 0.9000 \left( \frac{1}{300} \right) \left( \frac{1}{1.00} \right) (500.0) = 1.50 \text{ mg} \]

% X in the Impure X = \(\frac{1.50 - \text{mg X}}{500.0 \text{ mg sample}} \times 100 = 0.300 \% X \) in the JLBH

5. DATA given:

Standard solutions are given as ppm ("parts per million") which may be interpreted to mean "mg Cu\(^{2+}\) per liter of aqueous soln."

See the accompanying plot of the standard solution data.

For the Unknown sample,

\[ 0.9824 \text{ g sample} \Rightarrow 250.0 \text{ mL} \Rightarrow A = 0.200 \]

On the standard plot, this absorbance reads 3.90 ppm (or 3.85 ppm) in the diluted sample.

Wanted value: % Cu in the original sample.

CALCULATION:

\[ \left( \frac{3.90 \text{ mg Cu}^{2+}}{1 \text{ L soln}} \right) \times 0.2500 \text{ L soln} \times \left( \frac{1}{982.4 \text{ mg sample}} \right) \times 100 = 0.0992 \% \text{ Cu} \]

which is 3.90 ppm

or 0.0990 \% Cu

if 3.85 ppm is used.