5. (a) To dilute the 0.1 *M* solution to ⅕ of its original concentration (0.002 *M*) would require one part of the original solution to four parts of water. To do this measure out 20 mL of the original solution with a pipet or buret and place it in the 100 mL volumetric flask. Fill the volumetric flask to the 100 mL line with distilled water to produce 100 mL of 0.020 *M* solution. Calculations to support the volumes discussed above come from the definition of molarity as follows:

0.020 *M* solution

$$\text{Molarity} = \frac{\text{\# moles solute}}{\text{L of solution}}$$

$$0.020\ M = \frac{\text{\# of moles of } CoCl_2}{0.100 \text{ L of } CoCl_2}$$

\# moles of $CoCl_2$ = 0.0020 moles

0.10 *M* solution

$$\text{Molarity} = \frac{\text{\# moles solute}}{\text{L of solution}}$$

$$0.10\ M = \frac{0.0020 \text{ moles } CoCl_2}{\text{L of } CoCl_2}$$

Volume of $CoCl_2$ = 0.020 L = 20 mL of solution

(b) The optimum wavelength for analysis would be the 510 nm because this wavelength has the smallest percent transmission and the largest absorbance. The experiment the student is to do uses the absorption of light.

(c) The concentration of this unknown solution is 0.050 *M* as determined from the graph of Absorbance vs. Concentration.

(d) ε which is the molar absorptivity of the solution, *l* is the distance the light travels through the solution, and *c* is the concentration of the absorbing solution ($A = \varepsilon lc$, where A is the absorbance).

(e) The presence of fingerprints on the vessel will provide an experimental concentration that is greater than the actual concentration because some of the light used in the experiment will be absorbed by the fingerprints before it reaches the solution. The solution will then absorb some of the remaining light. The intensity of the light that exits the solution will be compared to the original intensity of light to determine the absorbance and, therefore, the concentration of the solution. The higher the concentration of the solution, the greater the absorbance (the less light will exit the solution). Since the fingerprints absorb an unknown amount of light, the absorbance of the solution will appear greater than it actually is and the experimental concentration will be greater than the actual concentration.

(f) The method of determining the concentration of a solution via the absorbance of light depends on the solution's ability to absorb light. If a liquid is colored, it is because some component of the liquid absorbs light. The greater the concentration of the light-absorbing substance, the greater the absorption of light. A solution of NaCl is colorless and, thus, would not be appropriate for this experiment.