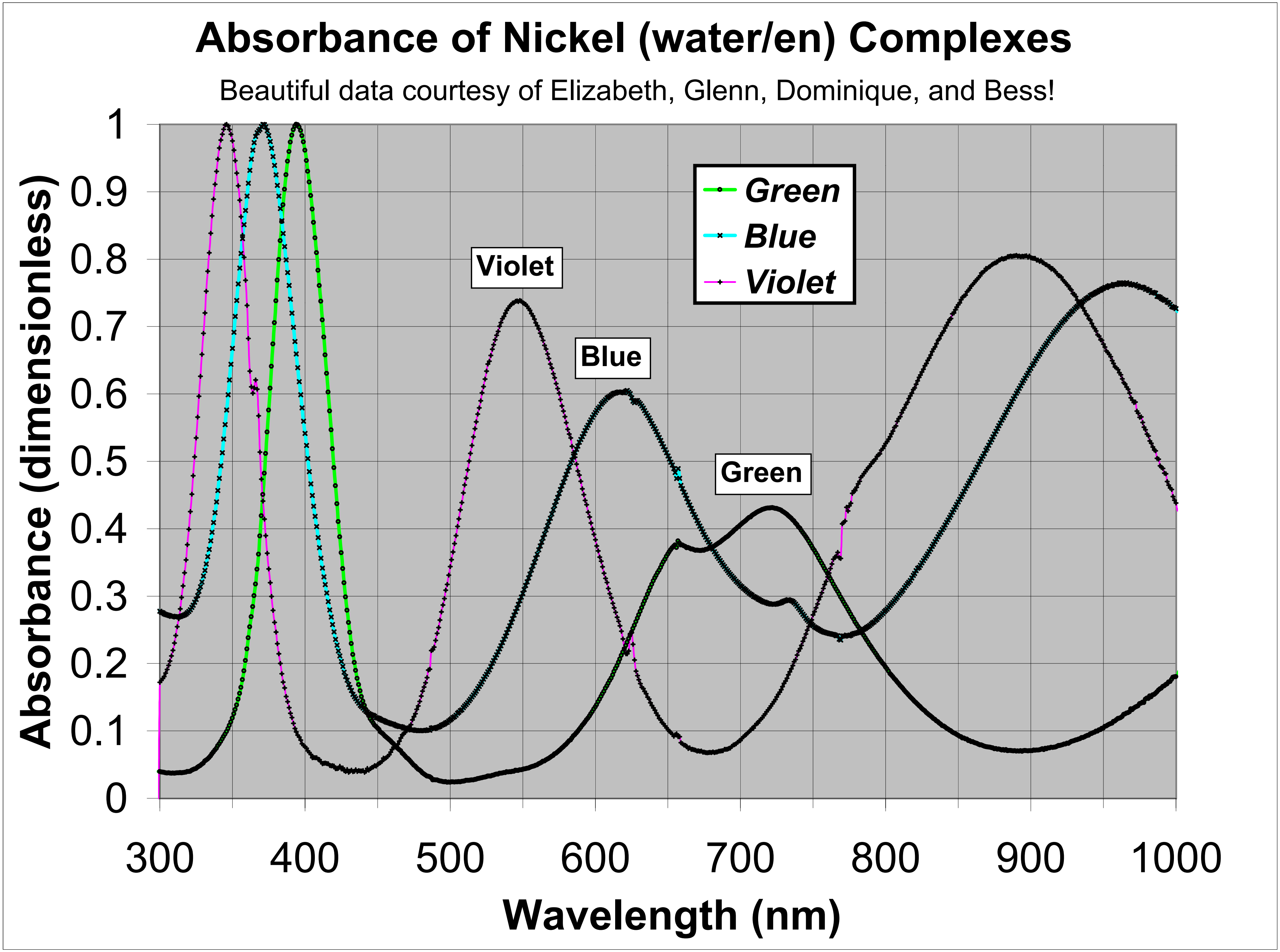

Absorbance of Nickel (water/en) Complexes
Beautiful data courtesy of Elizabeth, Glenn, Dominique, and Bess!
Absorbance (dimensionless)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
300
400
500
600
700
800
900
1000
Wavelength (nm)
Green
Blue
Violet
Violet
Blue
Green

From D. C. Harris, Quantitative Chemical Analysis, 2nd ed., W. H. Freeman & Co.: New York (1987), p.498.

See also your textbook, pp. 994-995.

When no light is absorbed, $P = P_0$ and $A = 0$. If 90% of the light is absorbed, 10% is transmitted and $P = P_0/10$. This gives $A = 1$. If only 1% of the light is transmitted, $A = 2$. The absorbance is sometimes called *optical density*, abbreviated OD or, occasionally, *E*.

The reason absorbance is so important is that it is directly proportional to the concentration of light-absorbing species in the sample:

Beer's law: $A = \varepsilon bc$.

$$A = \varepsilon bc \tag{20-6}$$

Box 20-1 explains why absorbance, not transmittance, is proportional to concentration.

Equation 20-6, which is the heart of spectrophotometry as applied to analytical chemistry, is called the Beer–Lambert law, or simply **Beer's law.** The absorbance, *A*, is a dimensionless ratio. The concentration of the sample, *c*, is usually given in units of moles per liter (M). The pathlength, *b*, is commonly expressed in centimeters. The quantity ε (epsilon) is called the **molar absorptivity** (or *extinction coefficient*, in the older literature) and has the units $M^{-1} \cdot cm^{-1}$ (since the product εbc must be dimensionless). The molar absorptivity, ε, is often expressed without dimensions, in which case $M^{-1} \cdot cm^{-1}$ should be assumed.

Equation 20-6 could be written

$$A_\lambda = \varepsilon_\lambda bc \tag{20-7}$$

because the values of *A* and ε depend on the wavelength of light. The quantity ε is simply a coefficient of proportionality between absorbance and the product *bc*. The larger the value of ε, the greater is *A*. An **absorption spectrum** is a graph showing how *A* (or ε) varies with wavelength. Demonstration 20-1 illustrates the meaning of an absorption spectrum and shows several examples of spectra.

The color of a solution is the complement of the color of light that it absorbs.

The part of a molecule responsible for light absorption is called a **chromophore.** Any substance that absorbs visible light will appear colored. A rough guide to colors is given in Table 20-1. The observed color is said

Table 20-1
Colors of visible light

Wavelength of maximum absorption (nm)	Color absorbed	Color observed
380–420	Violet	Green-yellow
420–440	Violet-blue	Yellow
440–470	Blue	Orange
470–500	Blue-green	Red
500–520	Green	Purple
520–550	Yellow-green	Violet
550–580	Yellow	Violet-blue
580–620	Orange	Blue
620–680	Red	Blue-green
680–780	Purple	Green