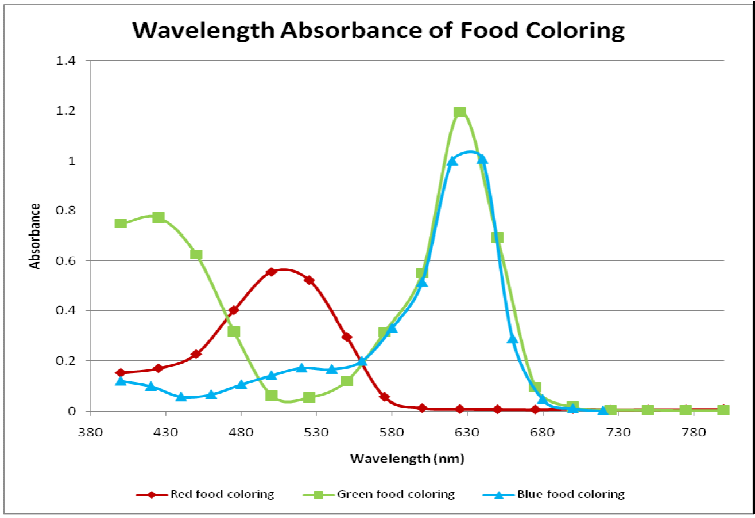
Studying the Visible Spectrophotometer

A. Data table for the chalk part

Color observed	wavelength (nm), Mike Ames	wavelength (nm), Grace Kim
Purple (faint)	404	392
Purple	418	-
Purple blue	430	448
Dark blue	458	458
Aqua	472	484
Blue Green	492	500
Green	510	523
Yellow Green	558	559
Yellow	564	572
Light orange (Orange yellow)	572	582
Orange	598	591
Red orange	604	604
Red	618	630
Deeper red	-	670
Red (faint)	700	710

B. Absorbance spectra from red, blue, and green solutions



Wavelengt	A (red)	A (green)		A(blue)
400	0.152	0.748	400	0.12
425	0.17	0.773	420	0.098
450	0.227	0.627	440	0.056
475	0.402	0.319	460	0.065
500	0.556	0.061	480	0.106
525	0.523	0.052	500	0.142
550	0.296	0.119	520	0.172
575	0.055	0.316	540	0.167
600	0.012	0.552	560	0.2
625	0.008	1.196	580	0.333
650	0.007	0.692	600	0.516
675	0.006	0.095	620	1.003
700	0.008	0.016	640	1.011
725	0.005	0.005	660	0.291
750	0.006	0.005	680	0.046
775	0.006	0.003	700	0.011
800	0.007	0.003	720	0.002

C. Questions

1. Sketch of optical path/ Spec 20 is attached w/ parts labeled.
   - •light bulb, provides a near full spectrum of light
   - •selector, attached to a prism that splits light into its differing wavelength lights; when selector moves, prism pivots so that different color light is directed toward slit/ sample compartment
   - •slit, in wall of sample compartment, is usually blocked unless level in sample compartment is tripped to allow light through. It narrows the beam so that only light of the desired wavelength is allowed to hit the sample
   - •detector, detects the intensity of light on other side of the sample compartment (I) so that % transmittance can be calculated.
   - •sample compartment, is where the spec tube with the colored solution is placed to be analyzed
   - •power switch/ 0 % transmittance adjustment—adjusts the intensity of the incoming light to zero
   - •100% transmittance adjustment, narrows beam

2. The wavelength range that could be detected by Mike and me, respectively, was 404-700 nm and 392-710 nm. The slightly larger range for me may be attributable to a difference in gender or maybe age (not as much eye damage). There were no major variations in the colors observed though Mike has some mild color blindness in not being as sensitive to differences in blue and green.

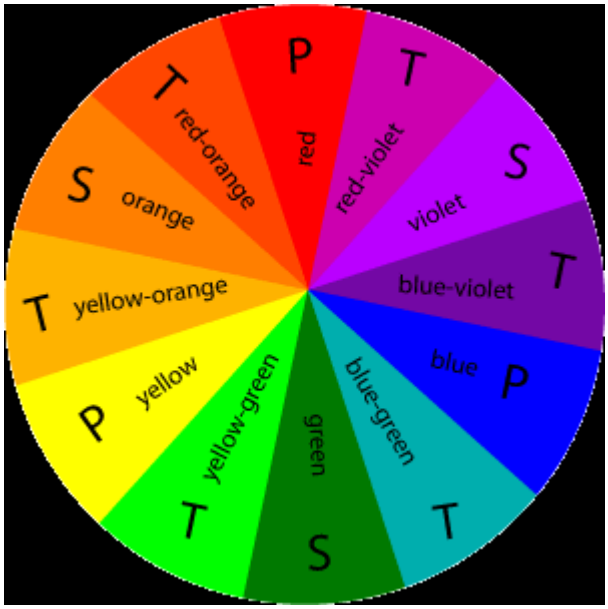


Figure 1. Color Wheel for reference for questions 3-8

3. Red solution.
   a) The wavelength range that exhibits the greatest absorbance is 480 nm-540 nm, which corresponds to the colors blue green, green, and yellow green.
   b) The wavelengths that aren't absorbed as strongly are 580-800 nm, which corresponds to the colors transmitted, predominantly orange and red, and the wavelengths from 380-420 nm, which corresponds to a violet color. Therefore, the integrated color seen is red.
4. Blue solution.
   a) The wavelength range that exhibits the greatest absorbance is 600-670 nm, which corresponds to the colors orange and a little red.
   b) The wavelengths that aren't absorbed as strongly are wavelengths less than 580 nm, which corresponds to the colors transmitted, which are violet, blue, green, and yellow green, yellow, and some orange-yellow. Therefore, the integrated color seen is blue.
5. The wavelengths a yellow solution should absorb should correspond to the complementary color on the color wheel, purple (~420 nm) or should average out to 420 nm (for example, absorbing ultraviolet at 240nm and orange at 600nm).
6. Red solution absorbs the higher energy light because red light absorbs predominantly green region and the blue solution absorbs predominantly in the orange-red region. Green light has a lower wavelength than orange-red light, so it has a higher energy ($E = hc/\lambda$).
7. The perceived color of a solution is typically the complementary color to the color(s) of light absorbed.
8. No, the green solution did not appear as expected. I expected it to absorb strongly only in the complementary color region or red light (600-700 nm). Instead, it absorbed strongly in the 600-670 nm region of orange/ red light and in the 400-480 nm region of violet, blue, and greenish blue light. The green color observed is the complementary color to the integrated colors absorbed.
9. n/a
10. On analog models, it is usually easier to measure % transmittance because it is just the ratio of light intensity detected after light has passed through a solution to the initial or blank light intensity ($\%T = I/ I_0$). However, higher end digital spectrometers can actually change the %T to absorbance, A, by doing the calculation $A = -\log(\%T)$. Absorbance is generally used when making spectroscopic measurements so that the numbers are all

within one order of magnitude, and because the absorbance (and not the %T) is linearly and directly related to the concentration (A=EcL).

11. Having only a few available wavelengths of light affects you ability to study colored solutions because, though this is rare, if your solution does not absorb light at the given wavelengths, it cannot be studied spectroscopically. If it does absorb the wavelength, but it is not the optimal wavelength of absorption, λ_{max}, the range of concentrations might be limited (your solution may reach 0 absorbance at low concentrations more quickly than if you were using an optimal wavelength).
12. 430 nm = purple- blue K_2CrO_4 (yellow)
    470 nm=aqua/ blue green $CoCl_2$ (pink/ red); $KMnO_4$ (purple/ pink)
    565 nm= yellow $CuSO_4$ (blue)
    635 nm = red $NiSO_4$ (blue/ green)