LAB [20 pts]
An Investigation of Color
flame tests, fluorescence, absorption spectra

Name _____
Lab Partner _____
Period _____ Date _____

Part 1: Flame tests— Emission of light due to the addition of heat **[5 pts]**

Data: Solutions and their Colors

Color	**Color**
a) LiCl _____	f) $BaCl_2$ _____
b) NaCl _____	g) $CuCl_2$ _____
c) KCl _____	Unknown A _____ Identity? _____
d) $CaCl_2$ _____	Unknown B_____ Identity? _____
e) $SrCl_2$ _____	Glass Rod _____ Identity?

Questions for flame tests:

1) When we looked at the neon light (emission spectrum), what type of energy excited the electrons (in the neon atoms) into higher energy levels? **(Electricity? Heat?)** _____
2) When doing these flame tests, what type of energy excites the electrons (in the compounds) into higher energy levels? (**Electricity? Heat?)**_____
3) As mentioned above, when doing the flame test, the electrons are first excited into a higher energy level. Explain why the flames have colors by explaining what happens to the electrons *next*.

4) If one looked at a red colored flame through a spectroscope, describe what one would be likely to see? *(continuous spectrum? distinct lines? What colors?)*

5) Watch the short video on fireworks. What propels a firework up into the air? What produces the colors of fireworks? What element is often used in red fireworks?

PART 2: **Fluorescence, phosphorescence, and Triboluminescence**

A. Fluorescence: [5 pts]

6) List all the fluorescent substances that we tested in class.

7) In class, what happened to the tonic water when I added salt?

8) Fluorescent substances only fluoresce when "black" light is used. Why is it called black light? What is "black" light? *(Read first two paragraphs of the article, "A Light Of A Different Color." **on website**)*

9) Explain the process of fluorescence. What is energy is absorbed? What happens to the electrons? What is emitted? *(Read in article under "Fluorescence")*

10) How does a fluorescent light work? *(Make sure you answer why the phosphors are necessary.)*

11) List how fluorescent substances can be used in the following situations. *(Read in sections in article called "Fluorescent Uses And Fluorescence In The Workplace."*
    a) for clothes_____
    b) by eye doctors_____
    c) by forensic scientists_____
    d) by geologists_____

B. Phosphorescence: [1.5 pts]

12) What is the common phrase used to describe substances which are phosphorescent? _____
13) Phosphorescent substances continue to glow after a light source is removed. Explain what is going on with the electrons to make this possible. (Read in article)

C. Triboluminescence: [1.5 pts]

14) What happens when you crush a Wint-O-Green Lifesaver? _____
15) Explain why this occurs. *(In article. Explain the entire process.)*

PART 3: Absorption [7 points]

A. **Introduction:** Some substances are colored-- others are not. Why???
It has to do with whether or not the substance absorbs visible light. When white light (contains all colors) shines on a colorless substance, all of the light is reflected by the substance. Thus, we just see the white light being reflected back at us. But, if the substance is colored, only some colors are being reflected back at us-- the other colors were absorbed by the substance. Thus, we see color because we only see the colors of light which are reflected back at us-- the light which was not absorbed. (The reflected light is not white light any more-- it has lost some wavelengths-- it is now colored).

Example: A blue shirt looks blue because only blue light is reflected-- all the other colors are absorbed.

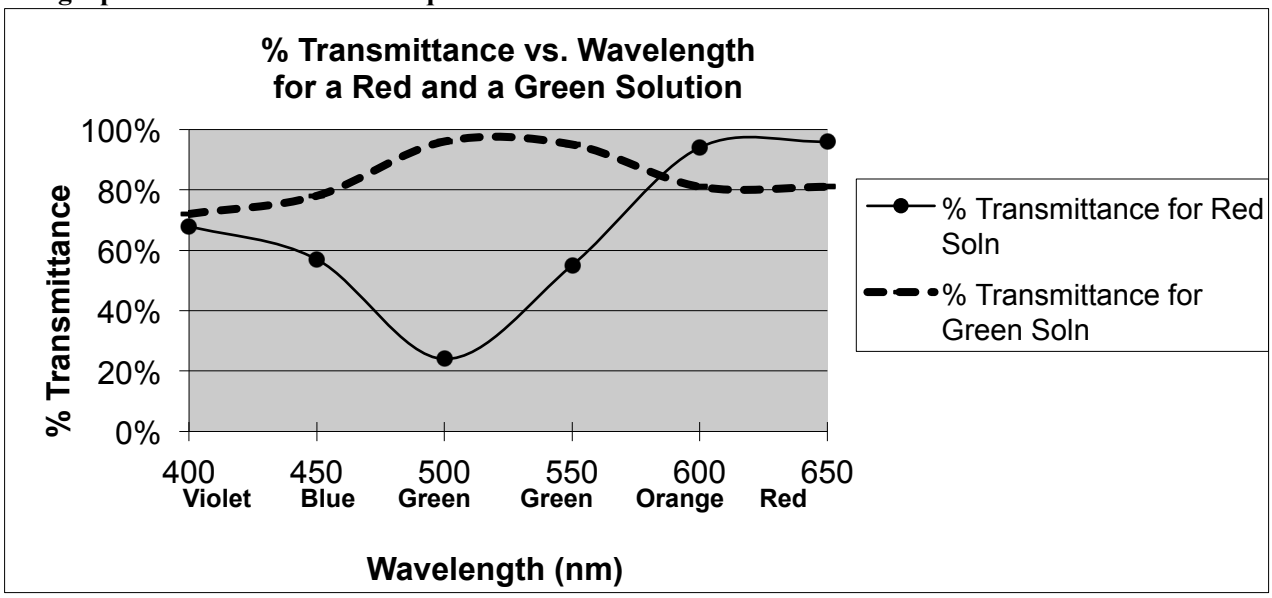
white light ----------> ***blue shirt*** ----------> mostly blue light is reflected
(ROYGBIV) (ROYG are absorbed)

B. **Evidence for this concept of color:** *Gathering data by using a spectrophotometer*
A spectrophotometer is a machine which sends out one wavelength of light, sends this light through a solution and then detects how much of that wavelength was transmitted through the solution.

Example:
Blue light ----------> solution ----------> % of blue light transmitted
(~450 nm) *(How much of the blue light goes through soln.)*
(Or in other words, the amount which is NOT absorbed.)

A spectrophotometer is useful, because one can test to see how much of each wavelength is transmitted by a solution. Below is a graph showing the % transmittance for a Red solution and a green solution. For each solution, the graph tells you how much of each wavelength is transmitted.

Analyze the graph below and answer the questions:



1) Look at the curve of the **red solution**.
   a) What wavelengths had the highest % transmittance? _____
   b) Thus, what colors are transmitted the most?_____
   c) What wavelength had the lowest % transmittance?_____ What color is absorbed the most?_____
   d) Does it make sense that the solution looks red?_____ Why?_____

2) Look at the curve of the **green solution**.
   a) What wavelengths had the highest % transmittance? _____
   b) Thus, what color(s) is transmitted the most?____
   c) Does it make sense that the solution looks green?_____ Why?_____

C. Involvement of electrons

Remember when we talked about neon lights (emission spectra)? We discussed how electrons jump up into a higher energy level when they absorb electricity. Then, when they fall down, they emit visible light.

Now, in the case of a colored shirt, electrons are jumping up when they absorb some wavelengths of visible light (and some wavelengths are transmitted--thus you see a color.) But, I know that you are wondering what is emitted when the electrons fall back down. We may be able to figure out the answer if we think about what is happening to electrons in a white shirt and a black shirt.

3) a) In order for a white shirt to look white, what colors must be reflected by the shirt?_____
   b) Thus, what colors are absorbed? _____
   c) Thus, do electrons absorb visible light and jump up into a higher energy level? _____

4) a) In order for a black shirt to look black, what colors must be reflected by the shirt?_____
   b) Thus, what colors are absorbed? _____
   c) Thus, do electrons absorb visible light and jump up into a higher energy level? _____

5) Now, you know that if you are outside on a sunny day, a black shirt will get a lot hotter than a white shirt. Why is this the case? A black shirt is hotter because it is emitting heat. A white shirt is not emitting heat. Now, lets see if we can connect these thoughts with our thoughts about electrons above.
   a) Explain why a black shirt gets so hot. (Discuss what happens to the electrons in the shirt.)

   b) Now, why doesn't a white shirt get as hot? (Talk about electrons again.)

D. A few last thoughts about color:

6) Is fruit punch still red when the refrigerator door is shut and there is no light shining on it? Explain and <u>justify</u> your answer.

7) Read the article entitled, *"Electromagnetic Spectrum"* ***on Website***
   a) Why is the sky blue?

   b) Why are sunsets a mixture of reds, oranges and yellows?