LAB-Chem Honors [25 pts]
An Investigation of Color
(flame tests, fluorescence, absorption spectra)

Name _____
Lab Partner _____
Period _____ Date _____

Station #1: Flame tests— Emission of light due to the addition of heat

Watch the video https://youtu.be/NEUbBAGw14k "MegaLab - Flame Test" and record the flame colors for each metal below. Examine the photos of the flames for each unknown, record the color, and identify the element.

Your choices of color are...**red (2 of them), red-orange, orange, light yellow, green, and pinkish purple**

Color	**Color**
a) Li _____	f) Ba _____
b) Na _____	g) Cu _____
c) K _____	Unknown A _____ Identity? _____
d) Ca _____	Unknown B_____ Identity? _____
e) Sr _____	Glass Rod _____Identity? _____

Station #2: Fluorescence/Phosphorescence/Triboluminescence :

a) In a dark box, use the black light to shine ultraviolet light onto the following substances. *(On the lamp, there is a black button to give higher energy UV light. There is a white button to give lower energy UV light. Push the black button to test all of these substances except for the dollar bills.)* Observe whether visible light is emitted. If visible light is emitted, state the color emitted. Don't forget to push red button to turn off the black light when done.

Mineral Rock#1:	Mineral Rock #2:	
Mineral Rock #3	Mr. Clean solution:	
Olive Oil:	White Paint	
Laundry Detergent:	White paper:	
Yellow Highlighter:	Pink Highlighter:	
Yellow Marker (not highlighter):	Blue Marker:	
$20 Bill: (push white button)	$10 Bill: (push white button)	$5 Bill: (push white button)
*(Demo)*Tonic Water:	*(Demo)*Tonic water with added salt:	

b) **Phosphorescent Frogs:** (Demonstration as a class)

- Shine the black light onto the frogs. What do you observe? _____
- Now, take away the black light. What do you observe? _____
- What is the common name of substances that behave as these rings do? _____

I will shine 3 different laser pointers on one of the frogs. Write what we observe with the:

- Red laser pointer: _____
- Green laser pointer: _____
- Violet laser pointer: _____

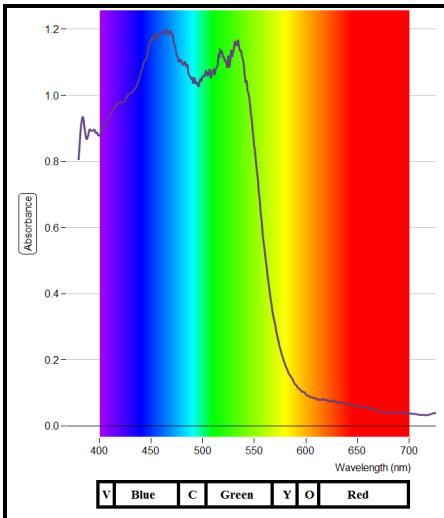
c) **Wintergreen Mints:** (Video: https://youtu.be/tW8q_JfmcbU)

What do you see when the mints are crushed or broken? _____

_____

Station #3: Absorption Spectra of differently colored solutions

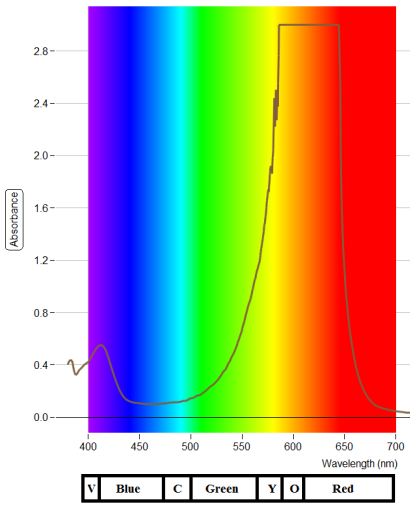
- The following six absorption spectra were obtained using a PASCO Spectrometer. Each spectrum was obtained by testing one of the following solutions: **red, yellow, green, blue, magenta, colorless**
- Look at each spectrum below. Fill in colors highly absorbed and colors highly transmitted for each. (*Limit your color choices to Red, Green and/or Blue, as in the notes.*)



Colors highly absorbed: _____

Colors highly transmitted: _____

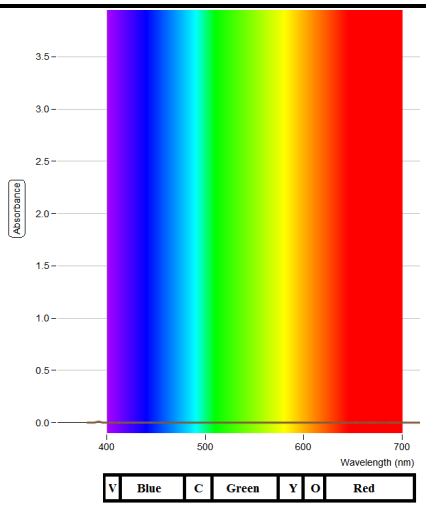
Color of soln #1: _____



Colors highly absorbed: _____

Colors highly transmitted: _____

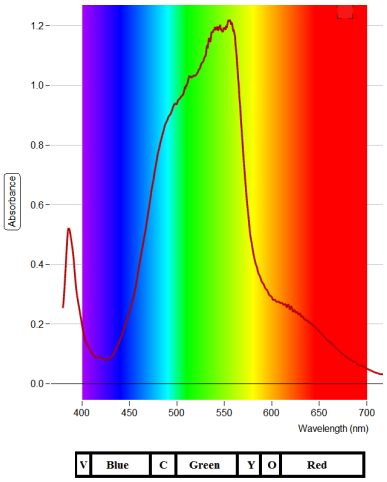
Color of soln #2: _____



Colors highly absorbed: _____

Colors highly transmitted: _____

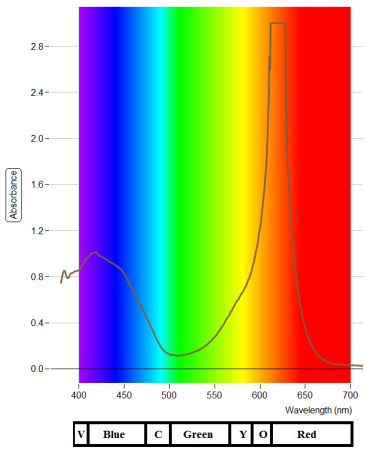
Color of soln #3: _____



Colors highly absorbed: _____

Colors highly transmitted: _____

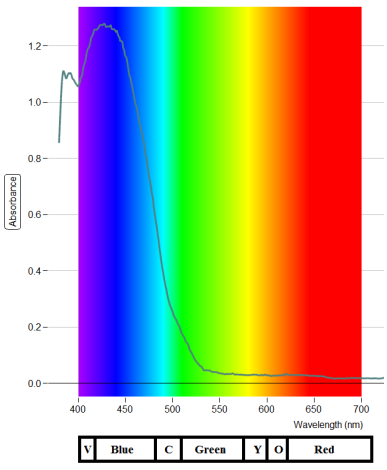
Color of soln #4: _____



Colors highly absorbed: _____

Colors highly transmitted: _____

Color of soln #5: _____



Colors highly absorbed: _____

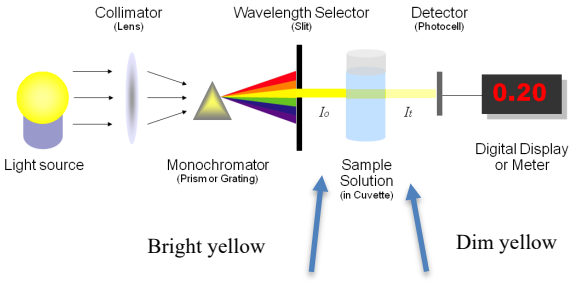
Colors highly transmitted: _____

Color of soln #6: _____

- Now, use the PASCO spectrometer to obtain the absorption spectrum for each solution. To do so, ….
  1. Place a cuvette with a colored solution into holder. Orient the cuvette so that the light will travel through the smooth sides of the cuvette. Look at the spectrum given by spectrometer.
  2. Match the solution color to one of the spectra above and write the color into the space.
  3. Repeat process for other 5 solutions.

Station #4: Using a "Spec 20": A "Spec 20" is a basic type of spectrometer that sends one wavelength at a time through a solution. It detects how much of that wavelength is absorbed. The higher the number, the more of that wavelength is absorbed.

As shown at right, yellow light is sent through the soln. Some of that yellow light is being absorbed, so dimmer yellow light is transmitted through the soln.



Part A: At the Spec 20 on the left side of the bench, open the solution compartment, and look down to the bottom of the test tube. Observe the color of the light sent into the test tube as you slowly turn the wavelength dial. It is easiest to start around 650 nm and turn dial to reduce wavelength.

a) Record the colors you see at the following wavelengths:
650 nm = _____ 525 nm= _____ 450 nm= _____ 380 nm = _____

b) **Explain** reason for the color you saw at 380 nm: _____

Part B: At the Spec 20 at the right side of the bench, the wavelength is set at 650 nm. (Do not change λ)

a) Put the test tube containing the red solution into the solution compartment.
What is the absorption of the 650 nm light for this **red solution**? _____

b) Take the red solution out, and put in the test tube containing the green solution.
What is the absorption of the 650 nm light for this **green solution**? _____

c) What color light is 650 nm light? _____

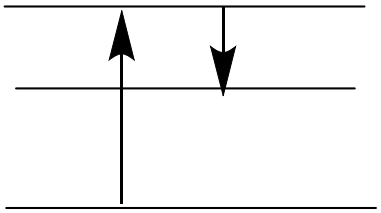
d) Which solution absorbed **less 650 nm** light? _____ Why does absorbing less 650 nm light give rise to the solution's color? _____

e) Which solution absorbed **more 650 nm** light? _____ Why does absorbing more 650 nm light give rise to the solution's color? _____

Post Lab Questions:

Questions relating to Station #1: Flame Tests

1) The diagram to the right represents what happens to electrons when a substance is placed in a flame and colors are seen.
   a) **Label** the upwards arrow with the type of energy that is absorbed by the electron.
   b) **Label** the downwards arrow with the type of energy emitted when the electron relaxes back down.



2) Why does an excited electron naturally relax back down? (Include the name of force involved.)

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

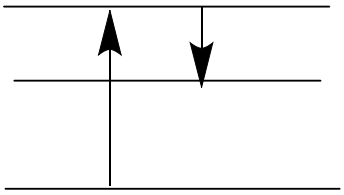
4) Watch the 6 minute video called "The Chemistry of Fireworks." (https://youtu.be/nPHegSulI_M).
   a) Potassium nitrate is a possible _____ that can be used in fireworks.
   b) Sulfur, charcoal, Al powder, and Mg powder are all possible _____used in fireworks.
   c) What color is the hardest to produce in fireworks? _____
   d) What element gives a white spark effect? _____
   e) Referring to the flame test data, what element might you use to create red fireworks? _____

Questions related to Station #2: Fluorescence, phosphorescence, and Triboluminescence

Read the Chem Matters article, "Light of a Different Color." and answer the following questions:

5) Fluorescent substances only fluoresce when "black" light is used. *(Read first two paragraphs of the article.)*
   a) Why is it called black light? _____
   b) What is "black" light? _____

6) Explain the process of fluorescence. What type of energy is absorbed? What happens to the electrons? What is emitted? Explain in words and label diagram at the right. *(Read section, "Fluorescence")*



7) How does a fluorescent light work? *(What element is involved and how do the phosphors work?)*

8) Briefly 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_____

9) Phosphorescent substances continue to glow after a light source is removed. Explain what is going on with the electrons to make this possible. *(Read "Phosphorescence" in the article.)*

10) [1 pt] Explain why the phosphorescent frogs behaved the way you observed when illuminated by laser light. Which laser color(s) were able to excite the electrons enough to cause the frogs to glow? Which were not? How can this be explained in terms of the energy of the photons produced by each laser? Describe and compare each laser's energy to make your explanation.

11) Triboluminescence occurs when a wintergreen mint is crushed. Explain what happens to electrons and why a flash of visible light is emitted. *(Read the Triboluminescence section of article.)*

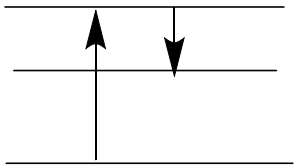
Questions relating to Stations #3&4: Absorption Spectra

12) A white shirt looks white because it absorbs _____ colors and reflects _____ colors.

13) A black shirt looks black because it absorbs _____ colors and reflects _____colors.

14) If you are outside on a sunny day, the surface of a black shirt will get hotter than that of a white shirt. Why is this the case? To answer this question, you need to know that the absorption of microwave or infrared(IR) radiation by a substance can cause the substance to heat up by increasing the motion of its molecules. *(Microwave radiation makes molecules rotate and IR radiation makes bonds vibrate.)*

a) As you know, if visible light is absorbed by a substance, an electron can be excited into a higher energy level. After being excited, the electron usually relaxes back down in small steps, emitting IR radiation. On the diagram at the right, **label the arrows** with the type of energy absorbed and type of energy emitted if this process occurs.



b) Use the information given in this question to explain why a black shirt gets hotter than a white shirt when in the sun. *(You must discuss electrons and explain what happens in each shirt.)*

15) Answer these questions about the color of a red apple.

a) Why does a red apple look red when white light is shining on it? *(Make sure to state what is absorbed and what is reflected by the apple.)*

b) If the room is totally dark (no white light), what color will the "red" apple be? (Will the red apple still look red?) Explain and justify your answer by discussing what is absorbed and what is reflected.

c) Now let's say the red apple is in a totally dark room and then a blue laser light (with 450 nm wavelength) is shined on the apple. Assuming the red apple has the same absorption spectrum as the red solution tested at Station #3 of lab, what color will the "red" apple be? Explain by discussing what is absorbed and reflected.

16) Watch the video called, "Why do leaves change color?" at https://youtu.be/X0nWmTeQPfo and answer these questions.

a) What pigment makes leaves green? _____

b) Why do leaves lose their green color in the fall? _____

_____

c) What pigment is boosted by the presence of glucose? _____

d) What color do carotenoids give leaves? _____