LAB [35 pts]
An Investigation of Color
flame tests, fluorescence, absorption spectra

Name _____
Lab Partner _____
Period _____ Date _____

Station #1:* [3 pts] *Flame tests— Emission of light due to the addition of heat

For each substance, dip the wire into the aqueous solution and hold it in a Bunsen burner flame. Observe the color of the flame produced. For each unknown, also identify the substance.
Your choices of color are...**red (2 of them), red-orange, yellow-orange, yellow-green, blue-green, and pinkish purple**

	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? _____

Station #2: [6 pts] 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.

*(Demo)*Tonic Water:	*(Demo)*Tonic water with added salt:	
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)

b) **Plastic Interconnected Rings**:
- Shine the black light onto the plastic rings. 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?_____

c) **Phosphorescent Frog:** (Demonstration as a class)
I will shine 3 different laser pointers on a phosphorescent frog. Write what we observe with the:
- Red laser pointer: _____
- Green laser pointer: _____
- Violet laser pointer: _____

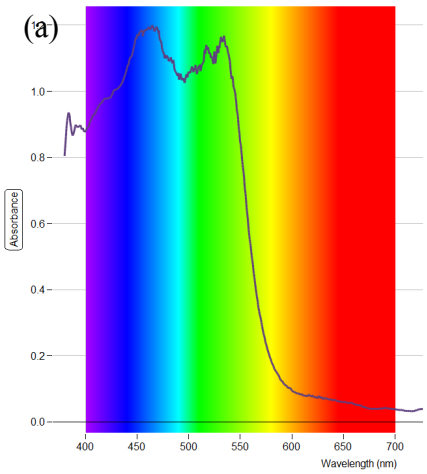
d) **Wintergreen Mints:** (Demonstration as a full class.)
As a class, we will go into the chemical storage room where it is pitch black. Once our eyes adjust, I will break a wintergreen mint with pliers. Did you see a flash of blue light? _____

Station #3: [3 pts] 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 spectra and label it with the color of its solution. Justify each choice with explanation.

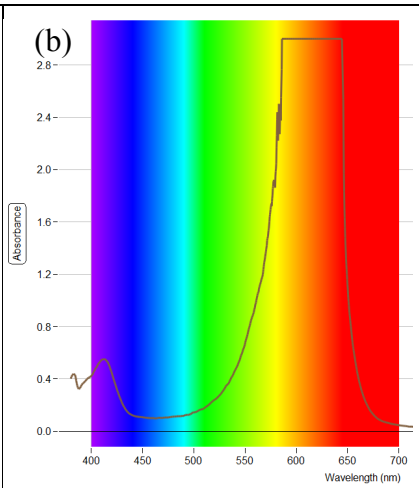
Color versions will be available at the lab bench

(a)



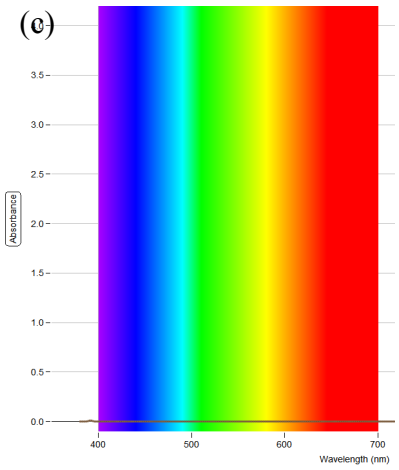
Color of solution: _____
Justify:

(b)



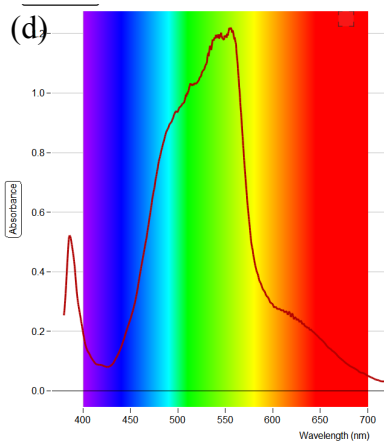
Color of solution:_____
Justify

(c)



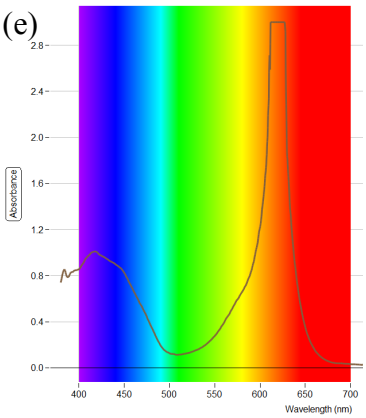
Color of Solution: _____
Justify.

(d)



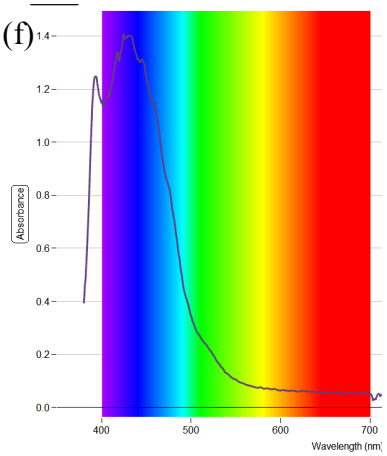
Color of Solution:_____
Justify.

(e)



Color of solution:_____
Justify.

(f)

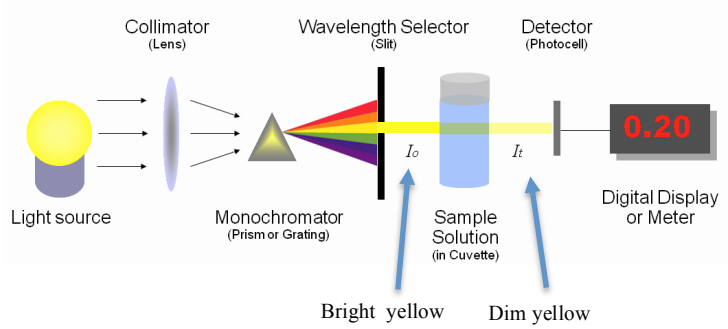


Color of Solution:_____
Justify.

- Now, obtain the absorption spectrum for each solution using the PASCO spectrometer. To do so, …. 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. You may press the "Scale to Fit" button if needed. Match the spectra obtained with one above and put a **"check mark**" next to the correctly identified color for that spectrum. Repeat process for other 5 solutions.

Station #4: [5 pts] 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. *In the diagram at the right, yellow light is sent through the solution. Some of that yellow light is being absorbed, so dimmer yellow light is transmitted through the solution.*



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 through the compartment as you slowly turn the wavelength dial. It is easiest to start around 650 nm and turn dial to reduce wavelength. Be the filter at the bottom is set properly for your wavelength.

- Record the colors you see at the following wavelengths:

  650 nm = _____ 525 nm= _____ 450 nm= _____ 400 nm = _____

- **Explain** your observation at 400 nm: _____

b) At the Spec 20 at the right side of the bench, the wavelength is set at 625 nm. (Do not change that.)

- What color light does this wavelength correspond to? _____
- Put the test tube containing the red solution into the solution compartment.

  What is the absorption of 625 nm light for this red solution? _____
- Take the red solution out, and put in the test tube containing the green solution.

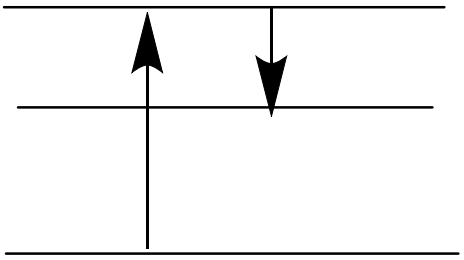
  What is the absorption of 625 nm light for this green solution? _____
- Which solution absorbed more 625 nm light? _____ **Explain why:**

- Which solution absorbed less 625 nm light? _____ **Explain why:**

Post Lab Questions:

Questions relating to Station #1: Flame Tests

1) [1 pt] The diagram to the right represents what happens to electrons when a substance is placed in a flame.
   - Label the upwards arrow with the type of energy that is absorbed by the electron.
   - Label the downwards arrow with the type of energy emitted when the electron relaxes back down.



2) [1 pt] Why does an excited electron naturally relax back down? (Include the name of force involved.)

3) [1 pt] 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?)*

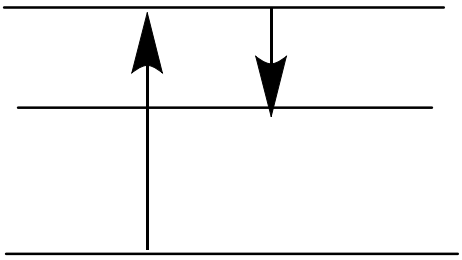
4) [1 pt] Watch the 6 minute video called "The Chemistry of Fireworks." (Posted on my YouTube channel).
   a) Potassium nitrate is a possible _____ that can be used in fireworks.
   b) Sulfur, charcoal, Al powder, and Mg powder are all possible _____ used in fireworks.
   c) What color is the hardest to produce in fireworks? _____
   d) What element gives a white spark effect? _____

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) [1 pt] 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.)*

6) [1 pt] 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 in article under "fluorescence")*



7) [1 pt] How does a fluorescent light work? *(Make sure you answer why the phosphors are necessary.)*

8) [1 pt] 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) [1 pt] Phosphorescent substances continue to glow after a light source is removed. Explain what is going on with the electrons to make this possible. (Read the phosphorescence section of 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) [1 pt] 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.) Note: there are **two** steps—you must explain both.*

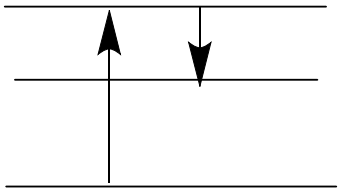
Questions relating to Station #3: Absorption Spectra

12) [1 pt] Why does a white shirt look white? *(What is absorbed? What is reflected?)*

13) [1 pt] Why does a black shirt look black? *(What is absorbed? What is reflected?)*

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 by a substance of EM radiation that is at least as energetic as microwaves can cause the substance to heat up. *(Microwave radiation makes molecules rotate, IR radiation makes bonds vibrate, visible and higher radiation can make molecules move around.)*

a) [1 pt] If a molecule absorbs visible light, the molecule might use the energy to move around faster or it might use the energy to excite an electron. If an electron is excited when it absorbs visible light, 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 emitted.



b) [1 pt] Use the information given in this question to explain why a black shirt gets hotter than a white shirt when in the sun.

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

a) [1 pt] 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) [1 pt] If the room is totally dark (no white light), will the red apple still look red? Explain and <u>justify</u> your answer by discussing what is absorbed and what is reflected.

c) [1 pt] 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 #6 of lab, will the red apple look red? Explain.

16) [1 pt] Watch the two minute clip (on my YouTube channel) called, "Why do leaves change color?" 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?_____