Absorption and Emission of Light in Metals

Names _____

Introduction:

Just as a fingerprint is unique to each person, the color of light emitted by metals heated in a flame is unique to each metal. In this lab, the characteristic color of light emitted for calcium, copper, lithium, potassium, sodium, and strontium will be observed.

Background:

When a substance is heated in a flame, the substance's electrons absorb energy from the flame. This absorbed energy allows the electrons to be promoted to excited (or higher) energy levels. From these excited energy levels, the electrons naturally want to make a transition, or relax, back down to the ground state. When an electron makes a transition from a higher energy level to a lower energy level, a particle of light called a **photon** is emitted.

An electron may relax all the way back down to the ground state in a single step, emitting a photon in the process. Or an electron may relax back down to the ground state in a series of smaller steps, emitting a photon with each step. In either case, the energy of each emitted photon is equal to the difference in energy between the excited state and the state to which the electron relaxes.

The energy of the emitted photon determines the color of light observed in the flame. Because colors of light are commonly referred to in terms of their wavelength, the equation below is used to convert the energy of the emitted photon to its wavelength.

$$\Delta E = \frac{hc}{\lambda}$$

In this equation,

ΔE = the difference in energy between the two energy levels in Joules.

h = Plank's constant (6.626×10^{-34} J Sec)

c = Speed of light (2.998×10^{8} m/sec)

λ = wavelength of light in meters

Wavelengths are commonly listed in units of nanometers ($1m = 1 \times 10^{9}$ nm), so a conversion between meters and nanometers is generally made.

The color of light observed when a substance is heated in a flame varies from substance to substance. Because each element has a different electronic configuration, the electronic transitions for a given substance are unique. As a result, **the color observed when a substance is heated in a flame can be used as a means of identification**.

The following table lists the wavelengths associated with each of the colors of the visible spectrum. The representative wavelengths are used as a benchmark for each color.

Representative (Ideal) Wavelength (nm)	Wavelength Region (nm)	Color
410	400-425	Violet
470	425-480	Blue
490	480-500	Blue-green
520	500-560	Green
565	560-580	Yellow-green
580	580-585	Yellow
600	585-650	Orange
650	650-700	Red

Step 1: Using your knowledge and the Periodic Table, write the chemical formulas for the following compounds you will be using in today's lab:

Name	Chemical Formula
Calcium Chloride	
Copper (II) Chloride	
Lithium Chloride	
Sodium Chloride	
Potassium Chloride	
Strontium Chloride	

Step 2: Get instructor's signature _____.

Step 3: Acquire safety gear (Goggles, apron) for each member of your team.

Step 4: Set-up your apparatus – Bunsen Burner, 400 mL beaker filled with distilled water, 250 mL beaker with tap water. Place wooden splints in distilled water.

Step 5: Place six test tubes in your test tube rack. Label each one with a pencil with a number 1 through 6.

Step 6: Acquire metallic salts in your test tube (about ¼" in each) , taking care not to spill. Match the test tube number with the sample!!! (See table below).

Step 7: Light the Bunsen burner.

Step 8: Dip the soaked end of one of the wooden splints into one of the metallic salts, then place the splint in the flame. Observe the color of the flame. Extinguish the splint by dipping into the beaker full of tap water. If you need to repeat the experiment, dip the splint into the metallic salt and repeat.

Step 9: Record your results in the Data Table below.

Step 10: Repeat steps 8-9 with each of the metallic salts.

Step 11: Clean up your lab area – then proceed to next page.

Test tube number	Metallic Salt	Color of Flame
1	Calcium Chloride	
2	Copper(II) Chloride	
3	Lithium Chloride	
4	Potassium Chloride	
5	Sodium Chloride	
6	Strontium Chloride	

Data Analysis

Fill out the data table below. In the first column, write the name of the **metal** in the metallic salt and the color of the flame. In the second column, write the **Representative Wavelength** for the color (look at the table on page 2). Convert the nm to m ($1m = 1 \times 10^9 nm$) and record in the third column.

In the final column, calculate the change in energy using the formula on page 1. Record your answer.

Metal/Color of Flame	wavelength (nm)	wavelength (m)	Change in Energy (J)

Using your knowledge, predict which color the following metallic salts would burn:

	Predicted Color of Flame
Copper (II) nitrate	
Sodium sulfate	
Potassium nitrate	

Next, see the instructor to get web info on Fireworks and to answer the following questions:

1. What metal would you use in a fireworks show to produce white flames? _____

2. What metal would you use for orange? _____

3. Which metal is used for glittering effects? _____