+ **Flame Test Lab** Name: ________________

Chemists began studying colored flames in the 18th century and soon used "flame tests" to distinguish between some elements. Different elements burn with different colored flames. Although some of the flames you will be seeing will appear similar in color, their light can be resolved (separated) with a prism into distinctly different bands of colors on the electromagnetic spectrum (ROYGBIV). These bands of colors are called ***atomic line spectra***, and they are UNIQUE to each element.

Niels Bohr studied the line spectrum for hydrogen, and wondered what the specific line spectrum had to do with the structure of the atom. He postulated that an electron can have only *specific energy values in an atom*, which are called **energy levels**. Bohr believed that the energy levels for electrons were **quantized**, meaning that only certain, specific energy levels were possible.

How does an electron move between energy levels? By gaining the right amount of energy, an electron can move, or *undergo a transition*, from one energy level to the next. We can explain the emission of the light by atoms to give the line spectrum like this:

1. An electron in a high energy level *(excited state)* undergoes a transition to a low energy level *(ground state)*. The transition is ***instantaneous*** & ***complete***.

2. In this process, the electron loses energy, which is emitted as a photon (a particle which behaves like a wave)

3. The energy difference between the high energy level and the low energy level is related to the frequency (color) of the emitted light.

Pre-lab questions:

1. Bohr's important discovery was that energy levels of electrons are *quantized* (only existing in certain, specific levels). In what year was this discovery made? (check WS 2.2) _____________

2. What happens to an electron when energy is added?

3. What is released when an electron loses energy?

4. What determines the frequency (color) of photons?

5. Why do you think the frequencies (color) for a specific element is always the same?

Procedure: In this lab, you will be observing the colors of the flames for 7 different elements: **lithium, sodium, potassium, calcium, strontium, barium,** and **copper.** Each element is dissolved in a solution of its chloride salt. There is a different solution at each lab station. You will go around to all 7, perform the flame test, and make **CAREFUL** observations of the colors. You will then be given an unknown solution, for which you will have to use your notes below to determine which unknown you were given. **Data Table**:

Li	Na	K
Ca	Sr	Ba
Cu	unknown # _____	unknown # _____

Based on your observations, what are the identities of your 2 unknowns?

Unknown # _____ is __________ **Unknown # _____ is ___________**

Post- Lab Questions:

1) If you had 2 colors that *seemed* identical, how could you tell them apart more accurately?

Albert Einstein determined this equation:

energy (in joules) of a photon is equal to ***Planck's constant*** times the ***frequency*** of the light:

$$E = h \cdot \nu$$

Frequency (ν) has units of 1/sec (which is a *Hertz*, or Hz)

• Planck's constant (**h**) = 6.63×10^{-34} J·sec

2a) If the frequency of a **red** spectrum line is at 1.60×10^{14} Hz, how much energy does each photon of this light have?

2b) If the frequency of a **violet** spectrum line is at 2.50×10^{14} Hz, how much energy does each photon of this light have?

2c) What is the frequency (ν) of light which has 8.33×10^{-22} joules?

Frequency (ν) and wavelength (λ) are mathematically related to each other: *their products equal the speed of light (c) which is 3.0×10^8 m/s.* $c = \lambda\nu$

3a) Calculate the wavelength (meters) of a photon whose frequency is 2.19×10^{14} Hz (sec^{-1}).

3b) Calculate the energy (joules) of a photon of light whose wavelength is 450 nm.

ANS(IRO+2):

4.02×10^{-20}, 1.06×10^{-19}, 1.66×10^{-19}, 1.37×10^{-6}, 1.92×10^{12}, 1.26×10^{12} **Units**: J, J, sec^{-1}, m