Name: _____

Partner #1: _____

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LAB: CHANGES IN ELECTRON ENERGIES

INTRODUCTION

According to the Bohr theory of the atom, electrons may occupy only specific energy levels. When an atom absorbs sufficient energy, an electron can "jump" to a higher energy level. Higher energy levels tend to be less stable, however, and if a lower energy level is available, the electron will "fall" back, giving off energy in the process. The difference in energies between the two levels is emitted in the form of a photon of electromagnetic radiation. The energy of each photon is described by the equation E = hv, where h is Planck's constant and v is the frequency of the radiation. If the wavelength of the released photon is between 400 and 700 nm, the energy is emitted as visible light. The color of the light depends on the specific energy change that is taking place.

White light is a continuous spectrum in which all wavelengths of visible light are present. An excited atom, however, produces one or more specific lines in its spectrum, corresponding to the specific changes in energy levels of its electrons. Because each element has a set of orbits with unique potential energies values, each element has a unique line spectrum.

Flame tests are a quick method of producing the characteristics colors of certain atoms. The loosely-held electrons of these atoms are easily excited in the flame of a lab burner. The emission of energy in the visible portion of the spectrum as those electrons return to lower energy levels produces a colored flame. The color is a combination of the wavelengths of each transition, and may be used to determine the identity of the atom. From your data, you will then be able to identify which atoms are in the unknown substances based on what color flame it produces upon exciting the electrons.

MATERIALS

Generate your own list by reading the directions.

PROCEDURE

Flame Tests

1. Remove a stick soaking in an aqueous ionic compound using tongs. Place the stick in a Bunsen burner flame for 10-15 seconds and record the color. Do NOT char the stick. Use the reference table on the board to determine the approximate wavelength. Return the stick to it's original container.
3. Repeat Step 1 with all 7 known solutions in data table A and one unknown solution.
4. If two metals are present in the same solution, the color of one flame may obscure that of the other. If cobalt glass plates are used, it is sometimes possible to absorb one color and not the other. Obtain a flask of sodium nitrate or potassium nitrate. Examine the flame through one or two thicknesses of cobalt glass. Repeat, using the other nitrate with the cobalt glass. Record the colors in data table B.
5. Flame-test a mixture of the solutions of the nitrates of sodium and potassium. Observe the color the mixture imparts to the flame when viewed without the cobalt glasses. Repeat the test, but observe the fame as seen through the cobalt glasses. Record the colors in data table B.
6. For each colored flame, determine a wavelength of light that corresponds to that color and record it in the table.

DATA TABLE

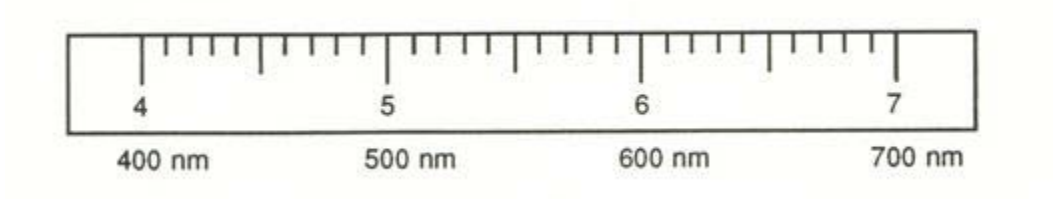
Compound (0.1 M solution)	**Color of Flame (without filter)**	**Color of Flame (with filter)**	**Wavelength λ (nm)**	**Frequency ν (1/s)**	**Energy (J)**
$Ba(NO_3)_2$		--			
$CaCl_2$		--			
$LiNO_3$		--			
KNO_3					
$Sr(NO_3)_2$		--			
$CuCl_2$		––			
$Cu(NO_3)_2$					
$NaNO_3$					
Mixture of $NaNO_3$ and KNO_3					
Unknown A					
Unknown B					

CALCULATIONS (SHOW THE WORK FOR ONE SAMPLE CALCULATION)

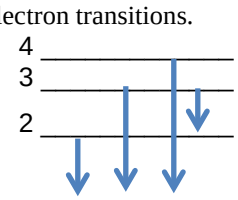
1. Rearrange the equation $c = \nu\lambda$ to solve for ν. Use the speed of light ($c = 3.0 \times 10^8 \frac{m}{s}$) to calculate the frequency for each of the solutions. Be sure to convert the wavelength to meters before you put it in the equation.
2. Use the frequency and Planck's constant (6.626×10^{-34} J·s) to calculate the energy of the light.

ANALYZE AND APPLY

1. In the flame tests, which part of the compound imparts the color of the flame, the cation (the metal ion) or the anion (chloride or nitrate)? Explain your logic.
2. During a flood, the labels from three bottles of chemicals floated away. The unlabeled bottles of white solids were known to contain the following: barium nitrate, ammonium carbonate, and potassium sulfate. Explain how you could easily re-label these three bottles.
3. Go to http://chemistry.bd.psu.edu/jircitano/periodic4.html and record the emission lines of Neon:



Consider the following electron transitions.



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Label these transitions with the wavelengths for the 4 emission lines of neon.

4. The unknown spectrum of a mixture of 2 elements is given here. Compare to the following knowns, identify what elements are in the unknown.

5. Helium was discovered in the Sun's corona during the eclipse of 1868. Later in 1888, helium was discovered on Earth. How could scientists be sure it was the same element?
6. Would you be able to use spectroscopy to identify elements if you were color-blind? Why or why not?
7. As a forensic scientist, you are given the task of identifying an unknown substance found at a crime scene. Which method do you think would provide more reliable results – a flame test or the emission spectrum? Explain.

CONCLUSION. For the flame test, identify the unknowns and justify your answer. Discuss sources of error and ways to improve.

INTRODUCTION (1-2 paragraphs)

Explain the Bohr model of the atom and how the Bo? Use the following terms: bright line spectrum, energy, wavelengths, discrete energy levels, continuous energy, fingerprint, excited state, ground state, absorbs, emitted, potential energy, electrons, orbit.