FLAME TESTS FOR *METALS*

Purpose: To observe and identify ***metal ions*** using flame tests

Background: Have you ever wondered why a candle flame is yellow? The characteristic yellow of a candle flame comes from the glow of burning carbon fragments. The carbon fragments are produced by the incomplete combustion reaction of the wick and candle wax. When elements, such as carbon, are heated to high temperatures, some of their electrons are excited to higher energy levels. When these excited electrons fall back to lower energy levels, they release excess energy in packages of light called ***photons***, or light quanta. The color of the emitted light depends on its energy. Blue light is more energetic than red light, for example. When heated, each element emits a characteristic pattern of light energies, which is useful for identifying the element. The characteristic colors of the light produced when substances are heated in the flame of a gas burner are the basis of flame tests for several elements. In this experiment, you will perform the flame tests used to identify several metallic elements.

Equipment: (per pair)

Safety goggles	1 nichrome wire/cork or toothpick	1 gas burner
1 porcelain spot plate	scoopulas (or cut straws)	1 50-mL beaker

Reagents: (solids or solutions)

KCl	$SrCl_2$	$CuCl_2$	$BaCl_2$
$Ca(NO_3)_2$ or $CaCl_2$	$LiNO_3$ or LiCl	NaCl	UNKNOWN SALT

Safety note: These solutions contain harmful materials. Avoid skin contact. Observe stated precautions and *standard laboratory procedures*. Wear your goggles, make note of the caustic and toxic materials you will be handling. You may choose to wear a lab apron. Dispose of chemicals per you teacher's instructions. Wash your hands.

Procedure: As you perform the experiment, record your observations in a Data Table of your own construction: Check to be sure which option your instructor has chosen.

Example: Record Unknown Number:_____

DATA TABLE: FLAME TESTS		
Ion	**Flame Color**	**Lines observed: Optional**
Sodium, Na^+	Yellow	If time permits spectroscopes may be used to view the emission spectrums

Lab Procedure:

1. Place the spot plate on top of a piece of white paper. Write the chemical name for each of the seven metal salts next to a position in the spot plate where each sample will be placed. Use scoopulas supplied with each salt to place a small grain-sized sample of each metal salt onto your spotplate.
2. Dip a new toothpick into the beaker of distilled water then touch a small grain of compound to allow it to stick to the toothpick then hold it in the flame of the Tirell burner.
3. Record the color of the flame in Data Table 1. Test the remaining samples, cleaning the wire loop as described in Step 2, before each new sample is tested. *Note: Test samples containing* ***sodium last****.* Record your observations.
4. Perform a flame test on your unknown salt. Record your observations and the Unknown number. Review your lab data determine the identity of your unknown.
5. Dispose of the samples used as directed by your teacher.

Analysis and Conclusion Questions:

1. List the elements that produced the most easily identified colors.
2. Which elements are least easily identified? Explain.

3. Which element produces the most intense color?
4. Would flame tests be useful for detecting metal ions present in a mixture of metal ions? Explain.
5. What does a flame test indicate about the energy changes taking place among the electrons in a metallic ion?
6. Explain why a metallic ion produces a characteristic color in a flame test, regardless of the compound used as the source of the ion.
7. What wavelengths correspond to the visible spectrum? Which color has the shortest wavelength? The longest?
8. List the metallic elements used in these flame tests in increasing order of the energy of the light emitted.
9. What precautions should be taken when using 6.0 M HCl?
10. Why it is important to clean nichrome wire for each test?
11. What is the purpose of using the cobalt glass in the identification of sodium and potassium?
12. Why were spectra observed only for alkali and alkaline earth metals?
13. Of the metal cations tested, sodium usually gives the brightest and most persistent color to the flame. What problems would this introduce if a real mixture containing both sodium and other cations were to be analyzed by the sort of technique used in this experiment? How could the problems be solved?
14. When a glass rod is heated, a yellow flame is observed around the point of heating. What does this yellow flame indicate?
15. The line spectrum of lithium has a red line at 670.8 nm. Calculate the energy of a photon with this wavelength.
16. What was the number of your unknown sample? What was the identity of your unknown compound? Assume it is the same compound that had the most similar flame color that you tested.
17. What is the difference between an emission spectrum and an absorbance spectrum?

Going Further:

In this lab, you observed that each element emits a unique color of light when heated in a flame. If these light emissions were examined through a prism, you would observe that the emitted light is actually composed of different wavelengths of light that may lie in the violet region, the green region, or the red region of the visible spectrum. Each element has a unique *emission spectrum*. Look up the emission spectra for the elements tested in this lab. *(See the chart in the classroom, online or other reference materials.)* How do scientists apply these emission spectra to investigate the chemical composition of stars? For example, what is the emission spectrum of the sun and what does this spectrum reveal about the types of elements in the sun?