**Flame Tests Lab**

*Use this worksheet as a guideline for the lab. Fill in the blanks and complete the chart of colors based on the video. You may also need to use the class notes to answer some of the ten (10) questions. Once completed, go to Study Place and complete the Test.*

**Learning Objective:**

Explain the movement of electrons between orbitals in an atom. Use the flame tests to identify substances.

Use the **Flame Tests Lab Video** to complete the worksheet below.

<http://somup.com/cqe2bonZ5o>

### **How Are the Fireworks Colors Made?**

Have you ever wondered how the beautiful colors of the fireworks are generated? Fireworks come in an array of colors from yellows and reds to blues and greens (**Figure 1**). The colors are produced by heating \_\_\_\_\_ salts. For example, sodium chloride (NaCl) burns \_\_\_\_\_, and calcium chloride (CaCl2) burns \_\_\_\_\_.

### **Electron States and Color**

Many elements and crystalline salts have a distinct color when burned over a flame. This color can be used to \_\_\_\_\_ a chemical compound (\_\_\_\_\_ property). The distinct color produced by each element is the result of the different \_\_\_\_\_ electrons in their specific \_\_\_\_\_.

The \_\_\_\_\_ state of an element is a specific electron arrangement that is the most energetically favorable. When an element is heated, the valence electrons \_\_\_\_\_ the energy from the heat, or become \_\_\_\_\_, and move to a \_\_\_\_\_ -energy orbital. Given that higher-energy orbitals are not \_\_\_\_\_, the excited electron quickly \_\_\_\_\_ to the ground state.

For example, sodium \_\_\_\_\_ has a 1s2 2s22p6 3s1 ground state \_\_\_\_\_ configuration. When sodium bonds ionically, its ground state electron configuration becomes 1s2 2s22p6 creating an overall \_\_\_ charge. When heated, electrons gain energy and can be \_\_\_\_\_ into a \_\_\_\_-energy level such as 4s as shown in **Figure 2**. Because this excited state is \_\_\_\_\_, the excited electron will drop back down to the ground state level and \_\_\_\_\_ energy as \_\_\_\_\_.

A **photon** of energy is given off as color so the sodium ion returns to the **ground state**.

One of the 2p electrons gets excited to 4s.

Sodium Ion Na+



**Figure 2. Sodium Ion Electron Configuration and Flame Color**

Electrons move from the \_\_\_\_\_ state to an \_\_\_\_\_ state when \_\_\_\_\_.

Depending on the amount of energy provided, more than \_\_\_\_\_ electron can be excited, and therefore more than one wavelength of light will be \_\_\_\_\_. It is common for ions to display \_\_\_\_\_ colors in their \_\_\_\_\_ spectra. In addition, the electron may not return all the way to the ground state, but to an \_\_\_\_\_ energy level. So, various wavelengths are possible from the same excited electron. The combination of the \_\_\_\_\_ emitted by an element gives the flame its \_\_\_\_\_.

The energy the valence electron absorbed when it was excited is re-emitted as a \_\_\_\_\_ of light. That photon has the \_\_\_\_\_, specific, \_\_\_\_\_ amount of energy needed to move that valence electron and thus has a particular \_\_\_\_\_. Therefore, the particular \_\_\_\_\_ emitted by an element or compound when it burns is caused by the particular wavelength of light emitted when its \_\_\_\_\_ electron moves from an \_\_\_\_\_ state to \_\_\_\_\_ state.

### **Limitations of the Flame Test**

Although the combinations of wavelengths of light emitted by each element are \_\_\_\_\_, the colors produced may be \_\_\_\_\_ enough that the naked eye may \_\_\_\_\_ be able to \_\_\_\_\_ similar colored ions from each other. Contaminants may also alter the color of the flame. For example, sodium is present in most compounds and will color the flame. A blue glass can filter out the yellow from sodium if necessary. Another limitation of the flame test is that it cannot detect very \_\_\_\_\_ concentrations of \_\_\_\_\_.

Use the **Flame Tests Lab Video** to complete the chart below.

<http://somup.com/cqe2bonZ5o>

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ion | Li+ | Na+ | K+ | Ca+ | Sr+ |
| Color |  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ion | Ba+ | Cu+2 | Cu+1 | Unknown |
| Color |  |  |  |  |

Question 1

What is possibly the unknown metallic ion shown in the Flame Tests Lab video based on the color?

- Lithium

- Copper

- Potassium

- Sodium

Question 2

When the metallic ions were placed in the heat, electrons jumped to higher energy level(s) from the \_\_\_ state to the \_\_\_ state. Color was given off as the electrons returned to the \_\_\_ state.

- excited … ground … ground

- ground … neutral … excited

- excited … ground … excited

- ground … excited … ground

Question 3

Electrons move between energy levels based on discrete, specific amounts of energy called

- absorption.

- quanta.

- emission.

- valence.

Question 4

Why do certain elements produce color when heated in a flame?

- Electrons are in a constant state of excitation that causes them to emit light.

- Electrons absorb energy from the flame and emit light to become excited.

- Electrons absorb energy from the flame and become excited. Upon returning to the ground state, they emit light.

- Electrons absorb photons of light from the flame and turn into colors of light.

Question 5

What is the ground state of an element?

- It is the arrangement of electrons that occurs whenever they are at room temperature or below.

- It is the arrangement of electrons that occurs after one or more electrons becomes excited.

- It is the most energetically favorable arrangement (lowest energy state) of the element's electrons.

- It is the most energetically favorable arrangement (lowest energy state) of the element's protons.

Question 6

Why did the different metal ions in solution produce different colored flames? - Actually, most metallic ions give off similar emission spectra.

- Elements with similar valence give off similar color.

- Only transition metals produce color when heated.

- Each element is the result of the different valence electrons in their specific orbitals.

Question 7

Which of the following statements is TRUE?

- Only one electron can be excited at a time.

- An electron may fall back to ground state in a single step or in multiple steps.

- Each element emits a single, characteristic wavelength of light during the flame test.

- Excited electrons do not return to ground state until they move away from the heat of the flame.

Question 8

The elements in this lab gave off colors of light. Which statement is NOT true?

- They exhibit the emission spectra.

- They exhibit the absorption spectra.

- Electrons return to a lower energy level by releasing color (light energy).

- Usually electrons are excited to a higher energy level by heat or electricity before returning to their ground state.

Question 9

What statement is TRUE concerning a flame test?

- Many elements and crystalline salts have a distinct color(s) when burned over a flame which can be used to identify a chemical compound.

- One cannot identify or distinguish different elements using flame tests.

- All elements produce similar flame tests because of electron configuration.

- Electrons, when heated, jump to a more stable energy state before returning to the ground state.

Question 10

Which statement BEST describes the Flame Tests?

- Always an intensive property.

- Never an intensive property.

- Intensive property as long as the colors differ.

- Always an extensive property.