

Flame Tests

Atomic Emission and Electron Energy Levels

Introduction

Just as a fingerprint is unique to each person, the color of light emitted by an element heated in a flame is also unique to each element. In this experiment, the characteristic color of light emitted by calcium, copper, lithium, potassium, sodium, and strontium ions will be observed.

Background

When a substance is heated in a flame, the atoms absorb energy from the flame. This absorbed energy allows the electrons to be promoted to excited energy levels. From these excited energy levels, there is a natural tendency for the electrons to make a transition or drop 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 (see Figure 1). Both the absorption and emission of energy are quantized—only certain energy levels are allowed.

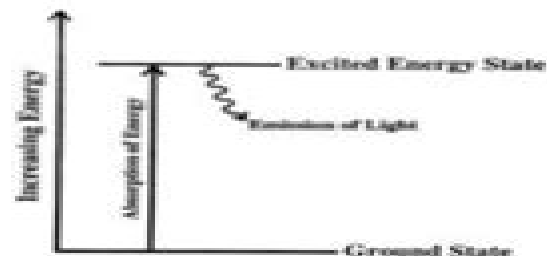


Figure 1. Absorption and Emission of Light.

An electron may drop all the way back down to the ground state in a single step, emitting a photon in the process. Alternatively, an electron may drop 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. The flame color may be described in terms of its wavelength, and Equation 1 may be used to calculate the energy of the emitted photon.

$$\Delta E = \frac{hc}{\lambda} \quad \text{Equation 1}$$

ΔE is the difference in energy between the two energy levels in joules (J),
 h is Planck's constant ($h = 6.626 \times 10^{-34}$ J sec)
 c is the speed of light ($c = 3.0 \times 10^8$ m/sec)
 λ (lambda) is the wavelength of light in meters. The wavelengths of visible light are given in units of nanometers ($1 \text{ m} = 1 \times 10^9 \text{ nm}$). See table 1 on the following page.

The color of light observed when a substance is heated in a flame varies from one substance to another. Because each element has a different spacing of electron energy levels, the possible electron transitions for a given substance are unique. Therefore, the difference in energy, between energy levels, the exact energy of the emitted photon, and the corresponding wavelength and color are unique to

Flame Test Atomic Emission And Electron Energy Levels Answers

A Loxley



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