Exciting Electrons

Exciting Electrons using LIGHT

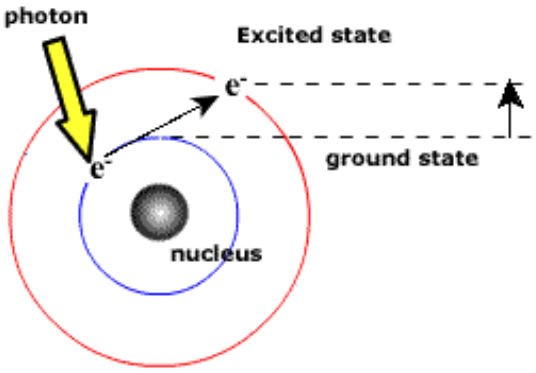
Adapted from: http://www.chemicalconnection.org.uk/chemistry/topics/view.php?topic=3&headingno=5
From The University of Edinburgh

When metals or metal salts are heated in a flame, the flame becomes highly coloured. These colours are due to the electrons getting excited!

Fireworks are made up of metal salts - they take advantage of the different colours that are produced when metal ions or atoms are heated.

Lithium (left), sodium (middle) and copper (right) salts give pink, yellow and green flame colours

What's the Chemistry?



The heat of the flame causes electrons in the metal atom to rise up to higher energy levels. This "excited state" is not stable so the electron falls back to its original energy level ("ground state"). As it falls, it releases the energy as LIGHT.

Why do different metals cause different flame colours?

Different metal atoms have different separations between their ground and excited states ("energy gap"). This means that they emit different amounts of energy when electrons fall from the excited state to the ground state.

Diagram #2

If you look at the spectrum of visible light below, you can see that different colours correspond to different energies (i.e. red light is at the 700 nm end of the spectrum and blue is at the 400 nm end).

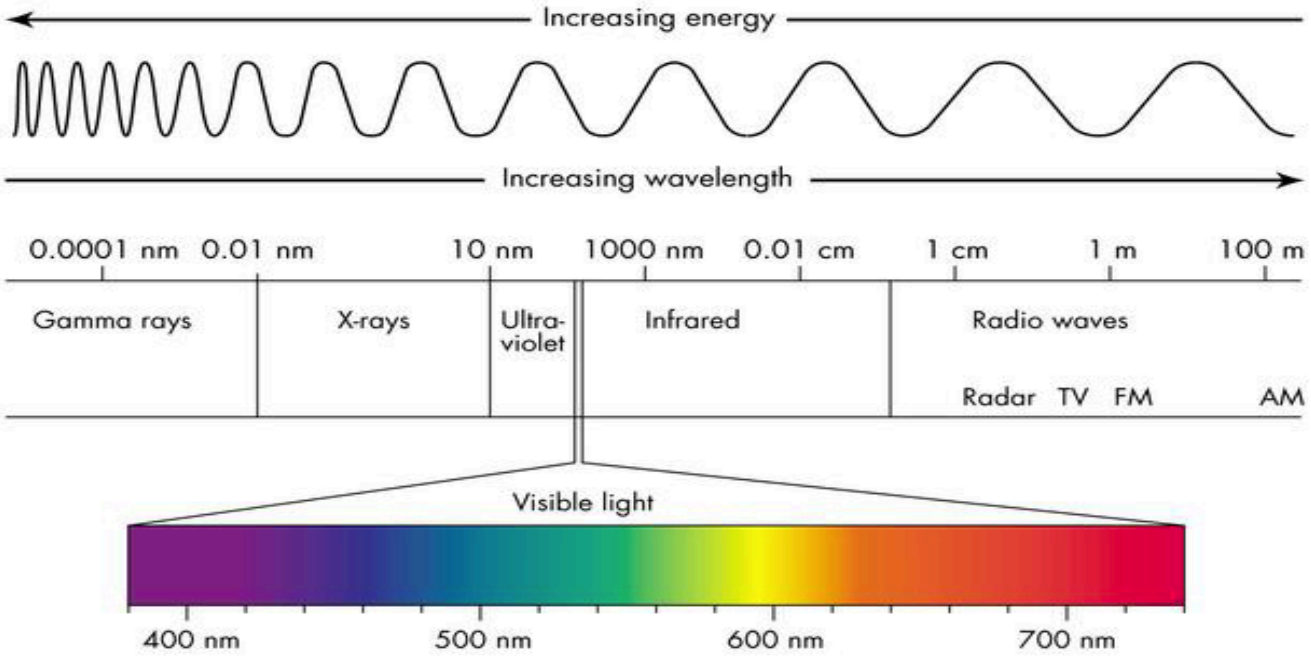


Diagram #3

nm= nanometre (one thousandth of a millionth of a metre (10^{-9}))

If a metal atom has a small energy gap, low energy visible light (e.g. red light) will be emitted as excited electrons fall back to their ground state.

If a metal atom has a large energy gap, high energy visible light (e.g. blue light) will be emitted as excited electrons fall back to their ground state.

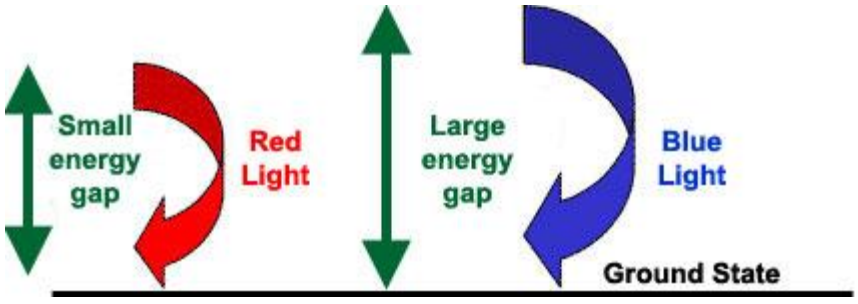


Diagram #4

How Do Fireworks Get Their Colors?

By Michelle Bryner | July 1, 2010 12:48pm ET Live Science

Credit: Tomislav Pinter | Dreamstime.com

Behind the scenes of the dazzling light shows that spectators ooh and ahh at on the Fourth of July, are carefully crafted fireworks. Whether red, white and blue fountains or purple sparklers, each firework is packed with just the right mix of chemicals to create these colorful lights .

Inside each handmade firework are small packets filled with special chemicals, mainly metal salts and metal oxides, which react to produce an array of colors. When heated, the atoms of each element in the mix absorb energy, causing its electrons to rearrange from their lowest energy state to a higher "excited" state. As the electrons plummet back down to their lower energy state, the excess energy gets emitted as light .

Each element releases a different amount of energy, and this energy is what determines the color or wavelength of the light that is emitted. For instance, when sodium nitrate is heated, electrons in the sodium atoms absorb the energy and get excited. When the electrons come down from the high, they release their energy , about 200 kilojoules per molecule, or the energy of yellow light, according to the website of the University of Wisconsin-Madison chemistry professor Bassam Z. Shakhashiri.

The recipe that creates blue, for example, includes varying amounts of copper chloride compounds, while red comes from strontium and lithium salts. Just like paints, secondary colors are made by mixing the ingredients of their primary-color relatives. A mixture of copper (blue) and strontium (red) makes purple.