Atoms and Electromagnetic Spectra

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-content, web-based collaborative model termed the **FlexBook®**, CK-12 intends to pioneer the generation and distribution of high-quality educational content that will serve both as core text as well as provide an adaptive environment for learning, powered through the **FlexBook Platform®**.

Printed: May 17, 2013

flexbook
next generation textbooks

CONCEPT 1 Atoms and Electromagnetic Spectra

Lesson Objectives

The student will:

- describe the appearance of an atomic emission spectrum.
- explain why an element can be identified by its emission spectrum.

Vocabulary

- emission spectrum

Introduction

Electric light bulbs contain a very thin wire that emits light upon heating. The wire is called a filament. The particular wire used in light bulbs is made of tungsten. A wire made of any metal would emit light under these circumstances, but one of the reasons that tungsten is used is because the light it emits contains virtually every frequency, making the emitted light appear white. Every element emits light when energized, either by heating the element or by passing electric current through it. Elements in solid form begin to glow when they are sufficiently heated, while elements in gaseous form emit light when electricity passes through them. This is the source of light emitted by neon signs (see **Figure** 1.1) and is also the source of light in a fire. You may have seen special logs created for fireplaces that give off bright red and green colors as they burn. These logs were created by introducing certain elements into them in order to produce those colors when heated.

FIGURE 1.1

The light emitted by the sign containing neon gas (on the left) is different from the light emitted by the sign containing argon gas (on the right).

Each Element Has a Unique Spectrum

Several physicists, including Anders J. Angstrom in 1868 and Johann J. Balmer in 1875, passed the light from energized atoms through glass prisms in such a way that the light was spread out and the individual frequencies making up the light could be seen.

FIGURE 1.2

This is the unique emission spectrum for hydrogen.

In **Figure** 1.2, we see the emission spectrum for hydrogen gas. The **emission spectrum** of a chemical element is the pattern of frequencies obtained when the element is subjected to a specific excitation. When hydrogen gas is placed into a tube and electric current passed through it, the color of emitted light is pink. But when the light is separated into individual colors, we see that the hydrogen spectrum is composed of four individual frequencies. The pink color of the tube is the result of our eyes blending the four colors.

Every atom has its own characteristic spectrum; no two atomic spectra are alike. Because each element has a unique emission spectrum, elements can be identified by using them. **Figure** 1.3 shows the emission spectrum of iron.

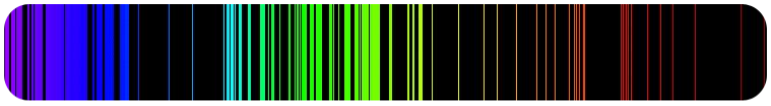

FIGURE 1.3

This is the unique emission spectrum of iron.

You may have heard or read about scientists discussing what elements are present in the sun or some more distant star. How could scientists know what elements are present if they have never been to these faraway places? Scientists determine what elements are present in distant stars by analyzing the light that comes from those stars and using the atomic spectrum to identify the elements emitting that light.

Lesson Summary

- Atoms have the ability to absorb and emit electromagnetic radiation.
- Each element has a unique emission spectrum.

Further Reading / Supplemental Links

This website "Spectral Lines" has a short discussion of atomic spectra. It also has the emission spectra of several elements.

- http://www.colorado.edu/physics/2000/quantumzone/index.html

Review Questions

1. The emission spectrum for an element shows bright lines for the light frequencies that are emitted. The absorption spectrum of that same element shows dark lines within the complete spectrum for the light frequencies that are absorbed. How can you explain that the bright lines in the emission spectrum of an element exactly correspond to the dark lines in the absorption spectrum for that same element?

References

1. Images of neon (http://en.wikipedia.org/wiki/File:NeTube.jpg) and argon (http://en.wikipedia.org/wiki/File:ArTube.jpg) signs created by Pslawinski, created into a composite by Richard Parsons. Neon and argon gas signs. CC-BY-SA 2.5
2. . HydrogenEmission Spectrum. Public domain
3. . Ironemission spectrum. Public domain