Blackbody Radiation Encyclopedia Article

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Blackbody Radiation

The term blackbody **radiation** refers to electromagnetic radiation emitted by a completely opaque object. Such an object is referred to as a blackbody since it absorbs all of the radiation that falls on it and thus appears to be colorless, or black. According to Kirchoff's law, any object that qualifies as a blackbody must also be a perfect emitter of radiation.

In fact, no real object fits the definition of a blackbody since even the most opaque of materials reflects some small fraction of the **light** incident upon it. Soot, **carbon** black, platinum black, and carborundum are among the materials that come closest to a blackbody in the real world. The concept of an idealized blackbody is still of major importance in physics. It serves as a standard for **heat** and **temperature** measurements just as the **wavelength** of light emitted by krypton-86 atoms is a standard for measurements of length.

For research purposes, physicists replicate the principle of a blackbody with a device known as a cavity radiator. A cavity radiator is a hollow sphere with a small hole through which radiation can enter and leave. Radiation that enters the hole is reflected continuously within the sphere until it is completely absorbed (as would be the case with a blackbody). It follows, then, that any radiation emitted by the cavity radiator corresponds to the definition of blackbody radiation.

The study of blackbody radiation was of considerable interest to physicists in the late 1800s. Experiments showed that for any given temperature, the intensity (brightness) of blackbody radiation is a maximum for a relatively narrow range of wavelengths, dropping off sharply at shorter and longer wavelengths. A number of attempts were made to use classical electromagnetic theory to derive a mathematical formula that would describe the intensity/wavelength relationship, but all failed for one or another part of the curve. Finally, in 1900, the German physicist **Max Planck** solved the problem. By assuming that radiation travels not in continuous **waves**, but in discrete "packages" (called **quanta**), Planck was able to derive a formula for the blackbody radiation curve. That formula is:

I = (/)[exp(c/kT - 1]–1

where is **Planck's constant**, k is Boltzmann's constant, is the wavelength of the radiation, and T is the absolute temperature.