Kirchoff's Law.

The ratio of emissive power to absorptive power is same for all surfaces at the same temperature and is equal to the emissive power of a perfectly black body at that temperature.

Thus if apractical and Epractical represent the absorptive and emissive power of a given surface, while ablack and Eblack for a perfectly black body, then according to law $\frac{E_{\text{practical}}}{a_{\text{practical}}} = \frac{E_{\text{black}}}{a_{\text{black}}}$

But for a perfectly black body ablack = 1 so $\frac{E_{\text{practical}}}{a_{\text{practical}}} = E_{\text{black}}$

If emissive and absorptive powers are considered for a particular wavelengthλ,

$$\left(\frac{E_\lambda}{a_\lambda}\right)_{\text{practical}} = (E_\lambda)_{\text{black}}$$

Now since (Eλ) black is constant at a given temperature, according to this law if a surface is a good absorber of a particular wavelength it is also a good emitter of that wavelength.

This in turn implies that a good absorber is a good emitter (or radiator)

Applications of Kirchoff's law

(1) Sand is rough black, so it is a good absorber and hence in deserts, days (when radiation from the sun is incident on sand) will be very hot. Now in accordance with Kirchoff's law, good absorber is a good emitter so nights (when sand emits radiation) will be cold. This is why days are hot and nights are cold in desert.

(2) Sodium vapors, on heating, emit two bright yellow lines. These are called D1, D2 lines of sodium. When continuos white light from an arc lamp is made to pass through sodium vapors at low temperature, the continuous spectrum is intercepted by two dark lines exactly in the same places as D1 and D2 lines. Hence sodium vapors when cold, absorbs the same wavelength, as they emit while hot. This is in accordance with Kirchoff's law.

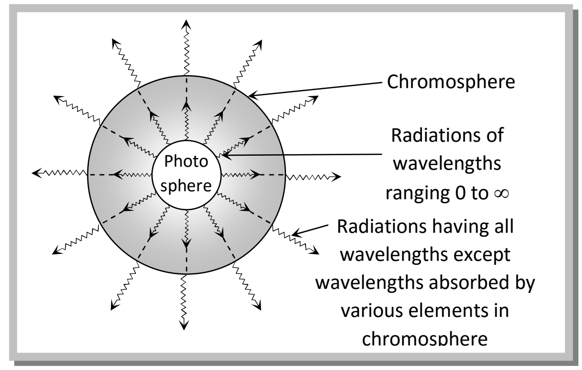
(3) When a shining metal ball having some black spots on its surface is heated to a high temperature and is seen in dark, the black spots shine brightly and the shining ball becomes dull or invisible. The reason is that the black spots on heating absorb radiation and so emit these in dark while the polished shining part reflects radiations and absorb nothing and so does not emit radiations and becomes invisible in the dark.

(4) When a green glass is heated in furnace and taken out, it is found to glow with red light. This is because red and green are complimentary colors. At ordinary temperatures, a green glass

appears green, because it transmits green color and absorb red color strongly. According to Kirchoff's law, this green

glass, on heating must emit the red color, which is absorbed strongly. Similarly when a red glass is heated to a high temperature it will glow with green light.

(5) Kirchoff' law also explains the existence of Fraunhoffer lines. These are some dark lines observed in the otherwise spectrum of the sun. According to Fraunhoffer, the central portion of the sun, called photosphere, is at a very high temperature and emits continuous light of all wavelengths. Before reaching us, the light passes through outer portion of the sun, called chromosphere. The chromosphere has some terrestrial elements in vapor form at lower temperature than that of photosphere. These elements absorb those wavelength which they would emit while hot. These absorbed wavelengths, which are missing appear as dark lines in the spectrum of the sun.



But during total solar eclipse these lines appear bright because the gases and vapor present in the chromosphere start emitting those radiation which they had absorbed.

(6) A person with black skin experiences more heat and colder as compared to a person of white skin because when the outside temperature is greater, the person with black skin absorbs more heat and when the outside temperature is less the person with black skin radiates more energy.