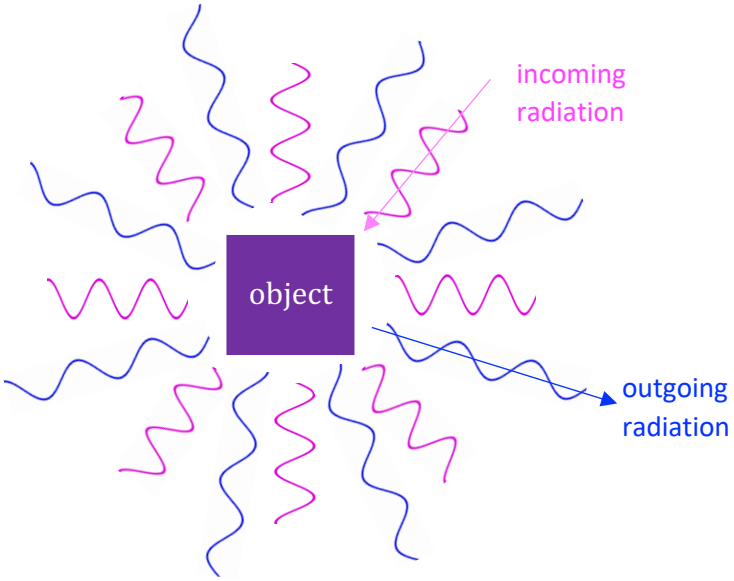
6.5 Black body radiation

videos

All objects emit and absorb electromagnetic radiation. As you would expect, matt black surfaces are good at absorbing visible light, and so reflect very little (and so appear black). White and shiny surfaces are poor at absorbing visible light, and so reflect more (and so appear light).



Objects also emit radiation. The hotter the object, the more radiation that is emitted.

As radiation carries energy, surfaces must emit radiation at the same rate as they absorb it to remain at a constant temperature.

(1) Matt black surfaces are better at absorbing radiation than light, shiny surfaces. What does this tell you about their ability to emit radiation compared to light, shiny surfaces?

Objects which are hotter than their surrounds will tend to emit more radiation than they absorb.

(2) How will this affect the temperature of the object?

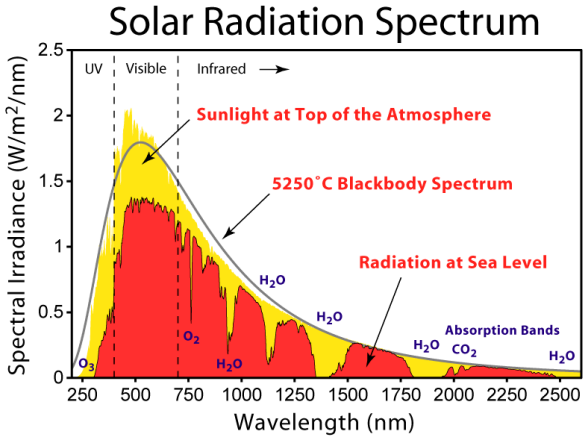
(3) How will the emission of radiation compare to the absorption of radiation for an object that is cooler than its surroundings?

Unless objects are very hot (e.g. white hot), they mostly emit radiation in the infrared part of the spectrum.

(4) What are we sensing when we hold our hand close to a radiator?

Black bodies

Black bodies are objects which absorb <u>all</u> radiation falling on them. They are 'perfect' absorbers. This means that they are also 'perfect' emitters. Black bodies don't exist (except mathematically!) but are a good approximation to the radiation emitted by stars.



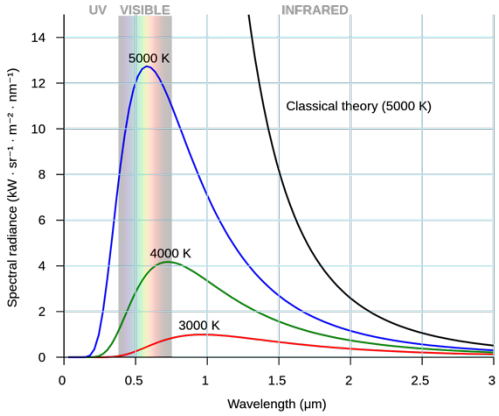
For example, if we take a look at the spectrum of light from the Sun (our nearest star), we can see that the sun emits radiation with a range of wavelengths from ultraviolet through to infrared. The peak wavelength lies towards the middle of the visible spectrum. As a consequence, the Sun appears a yellow colour.

The solid curve shows the emission of a black body at the same temperature as the Sun.

The diagram (right) shows the black body emission spectra for different temperatures.

(5) What do you notice about the position of the peak wavelength as the temperature increases from 3000K (in kelvin) to 5000K?

(6) What colour would stars be if they have a surface temperature of 3000K? Explain.



(7) As the temperature increases, how does the total amount of radiation change?

The Greenhouse Effect

Some radiation from the Sun is absorbed by the Earth's surface, some is reflected, and some is emitted. The radiation emitted by the Earth's surface is in the infrared part of the spectrum. Some 'greenhouse' gases (e.g. carbon dioxide, methane, water vapour) in the Earth's atmosphere absorb infrared radiation and stop some of it escaping into space. The net result is that the temperature of the Earth/atmosphere system increases

until a new equilibrium point is reached (where there is a balance between incoming and outgoing radiation).

(8) What is the effect of adding additional greenhouse gases to the atmosphere?

(9) What are the sources of additional greenhouse gases?

(10) The planet Venus has an atmosphere and has many similarities to the Earth. Why are the temperatures at the surface of Venus much hotter than on Earth?