Worksheet 2:

Red is cold and blue is hot

Friedrich Wilhelm Herschel himself tried to find out whether all colours in the Sun's spectrum have the same intensity or whether their intensity varies. But this was decades before accurate measurements could be made. The results were surprising: in the spectrum of a glowing body, the radiation always reaches a **maximum intensity** at a certain **colour (wavelength)**, and this maximum intensity depends on the **temperature** of the radiating body.

At the time, the search for a physical theory and mathematical description of this phenomenon was unsuccessful. But in 1900, the physicist **Max Planck** succeeded in developing a suitable theory and found an exact formula that describes the **radiation curve**. In 1918, Max Planck received the Nobel Prize in Physics for his groundbreaking research.

Exercises:

The mathematical description of the so-called **Planck curve** is too difficult to teach in school. Nevertheless, some key aspects of the radiation curve are clearly captured by a mini computer simulation.

Open the program "planck_curve.exe" (downloadable from the website: http://mabo-physik.de/plancksche_strahlungskurve.html) and make yourself familiar with how it works.

1. If you take a closer look at the radiation curve of the **Sun**, you'll notice that only part of the emitted radiation is in the visible range – a lot of the radiation is invisible to the human eye. Answer the following questions:

a) What percentage of the Sun's radiation can we see as visible light?

b) At what colour (wavelength) is the Sun's radiation at its maximum intensity?

c) Relative to the visible part of the spectrum, where are the infrared and ultraviolet regions?

d) What is the surface temperature of the Sun?

2. Now set the radiation source to the **incandescent lightbulb**.

a) What type of radiation does an incandescent lightbulb emit the most?

b) Using the radiation curve, explain why it made sense for the European Commission to ban the sale of incandescent lightbulbs a few years ago in favour of energy-saving lightbulbs or LED lamps.

3. Now, change the **temperature** of the glowing body, and observe how the **radiation curve** and the **overall colour** of the source changes. Write up your observations and explain how they relate to the title of this worksheet, “Red is cold and blue is hot”.

Did you know that...

...the relation between the maximum intensity of the radiation and the temperature of the radiating body is an excellent way for astronomers to determine the surface temperature of distant stars?

By recording the radiation spectrum of the star using a sensitive spectrometer, you can find the maximum of the radiation curve. From this, you can calculate the (approximate) temperature of the star’s surface. The Planck curve is like a thermometer for far-away objects.

