Planck's Radiation Equation Fit to Experimental Data

$n := 42$ $i := 1 .. n$

The data for this exercise is taken from page 19 of Eisberg and Resnick, *Quantum Physics*.

$\rho_i :=$	$\lambda_i :=$
.07	.667
.096	.720
.120	.737
.190	.811
.210	.838
.398	.917
.420	.917
.680	1.027
.708	1.021
1.036	1.167
1.062	1.172
1.258	1.247
1.669	1.484
1.770	1.697
1.776	1.831
1.730	2.039
1.685	2.170
1.640	2.275
1.551	2.406
1.392	2.563
1.145	2.827
1.115	2.827
1.071	2.916
1.042	2.921
.974	3.050
.918	3.151
.797	3.344
.760	3.450
.742	3.556
.698	3.661
.667	3.754
.570	4.027
.426	4.427
.378	4.613
.345	4.805
.310	4.968
.280	5.128
.250	5.296
.220	5.469
.205	5.632
.175	5.783
.155	6.168

The values of rho are given in units of 10^3 joules/m^3 and the values of lambda are given in 10^{-6} m. The temperature is 1595 K.

Define Planck radiation function and first derivatives with respect to parameters a and b:

$$F(\lambda, a, b) := \begin{bmatrix} \dfrac{a \cdot \lambda^{-5}}{\left(e^{\frac{b}{\lambda}} - 1\right)} \\ \dfrac{d}{da}\dfrac{a \cdot \lambda^{-5}}{\left(e^{\frac{b}{\lambda}} - 1\right)} \\ \dfrac{d}{db}\dfrac{a \cdot \lambda^{-5}}{\left(e^{\frac{b}{\lambda}} - 1\right)} \end{bmatrix}$$

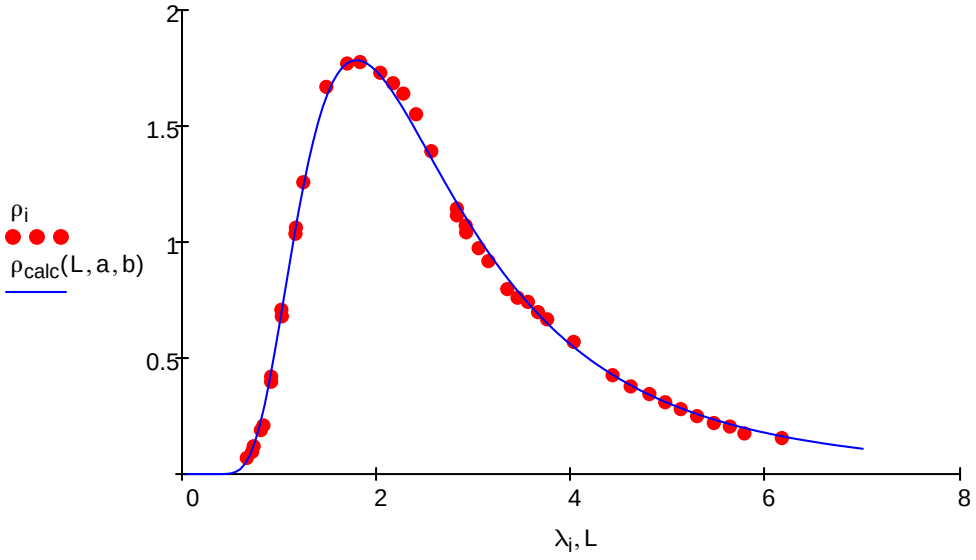
Carry out nonlinear regression using Mathcad's genfit algorithm:

$$seed := \begin{pmatrix} 5 \cdot 10^3 \\ 10 \end{pmatrix} \qquad P := genfit(\lambda, \rho, seed, F) \qquad P = \begin{pmatrix} 4.715 \times 10^3 \\ 8.906 \end{pmatrix} \qquad \begin{pmatrix} a \\ b \end{pmatrix} := P$$

Calculated radiaion equation using output parameters:

$$\rho_{calc}(L, a, b) := \frac{a \cdot L^{-5}}{\left(e^{\frac{b}{L}} - 1\right)}$$

Plot data and fit: $L := 0.05, .1 .. 7$



Calculate Planck's constant using the value of b, which is equal to (hc)/(kT).

$$h := \frac{b \cdot 10^{-6} \cdot 1.381 \cdot 10^{-23} \cdot 1595}{2.9979 \cdot 10^{8}} \qquad h = 6.544 \times 10^{-34}$$