Problem Set #1: Geothermal gradients

The expressions below can be used to calculate a conductive geothermal gradient for the lithosphere.

\[ T(z) = \frac{Qz}{K} + A_o \frac{z(b - z/2)}{K} + T_s \quad z < b \]

\[ T(z) = \frac{Qz}{K} + A_o \frac{b^2}{2K} + T_s \quad b \leq z \leq L \quad \text{where } L = 100 \text{ km} \]

where:
- \( T_s \) = surface temperature (°C)
- \( Q \) = mantle heat flow (mW/m²)
- \( K \) = thermal conductivity (W/m/deg)
- \( A_o \) = \( \rho H_s \) = heat production (µW/m³)
- \( b \) = characteristic depth of \( A_o \) (km)
- \( z \) = depth (km)

Using a spreadsheet (e.g. Excel), plot temperature (°C) vs. depth (km) for

a) the entire lithosphere (100 km), and

b) the upper 35 km. Plot depth as the y-axis and “negative” (i.e. going down the page from 0 km).

Answer the following questions:

1. What is the temperature at the base of the lithosphere? ______ at 35 km? ________.

2. Play around with some of the parameters. What do you need to do to get 700°C at 35 km? Is there a unique solution? Which parameters do you think we know best? the least?

3. The equations given above assume that heat flow in the lithosphere is by conduction only. Is this a reasonable assumption? Why or why not?