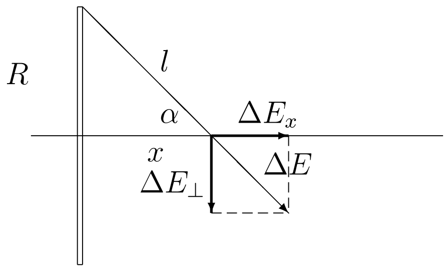

Figure 4:

This electric field strength can be decomposed into the component in the direction of the x-axis and the one perpendicular to the x-axis, see Figure 4. Magnitudes of both components obey

$$\Delta E_x = \Delta E \cos\alpha = \frac{\Delta E\, x}{l}\,,$$
$$\Delta E_\perp = \Delta E \sin\alpha\,.$$

It follows from the symmetry, that for every part of the ring there exists another one having the component $\Delta\vec{E_\perp}$ of the same magnitude, but however oppositely oriented. Hence, components perpendicular to the axis cancel each other and resultant electric field strength has the magnitude

$$E = E_x = n\Delta E_x = \frac{Q\,x}{4\pi\varepsilon_0\, l^3}\,. \qquad (12)$$

Substituting (12) into (11) we obtain for the cord length

$$l = \sqrt[3]{\frac{Q\,q\,R}{4\pi\varepsilon_0\, m\, g}}\,.$$

Numerically

$$l = \sqrt[3]{\frac{9.0\cdot10^{-8}\cdot9.0\cdot10^{-8}\cdot5.0\cdot10^{-2}}{4\pi\cdot8.9\cdot10^{-12}\cdot10^{-3}\cdot9.8}}\ \mathrm{m} = 7.2\cdot10^{-2}\ \mathrm{m}\,.$$

Problem 4. A glass plate is placed above a glass cube of 2 cm edges in such a way that there remains a thin air layer between them, see Figure 5.

Electromagnetic radiation of wavelength between 400 nm and 1150 nm (for which the plate is penetrable) incident perpendicular to the plate from above is reflected from both air surfaces and interferes. In this range only two wavelengths give maximum reinforcements, one of them is $\lambda = 400$ nm. Find the second wavelength. Determine how it is necessary to warm up the cube so as it would touch the plate. The coefficient of linear thermal expansion is $\alpha = 8.0 \cdot 10^{-6}\,{}^{\mathrm{o}}\mathrm{C}^{-1}$, the refractive index of the air $n = 1$. The distance of the bottom of the cube from the plate does not change during warming up.

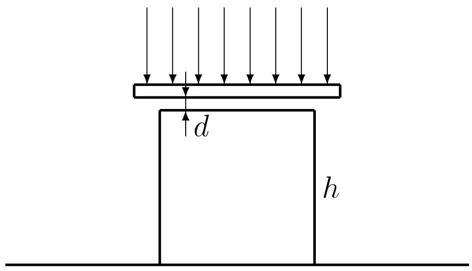

Figure 5:

Solution:
Condition for the maximum reinforcement can be written as

$$2dn - \frac{\lambda_k}{2} = k\lambda_k\,, \text{ for } k = 0, 1, 2, \dots\,,$$

i.e.

$$2dn = (2k+1)\frac{\lambda_k}{2}\,, \tag{13}$$

with d being thickness of the layer, n the refractive index and k maximum order. Let us denote $\lambda' = 1150$ nm. Since for $\lambda = 400$ nm the condition for maximum is satisfied by the assumption, let us denote $\lambda_p = 400$ nm, where p is an unknown integer identifying the maximum order, for which

$$\lambda_p(2p+1) = 4dn \tag{14}$$

holds true. The equation (13) yields that for fixed d the wavelength λ_k increases with decreasing maximum order k and vise versa. According to the