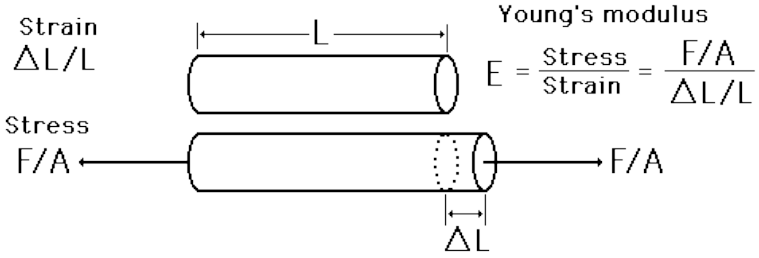
Answer on Question #53680, Physics / Mechanics | Kinematics | Dynamics

Calculate the tensile force required to produce an elongation of 0.1 percent in a wire of radius 0.5 mm. (The Young's modulus of the material of the wire is 1.0×10^{11} N m^{-2})

Solution:

For the description of the elastic properties of linear objects like wires, rods, columns which are either stretched or compressed, a convenient parameter is the ratio of the stress to the strain, a parameter called the Young's modulus of the material. Young's modulus can be used to predict the elongation or compression of an object as long as the stress is less than the yield strength of the material.



The stress is

$$\sigma = \frac{F}{A}$$

where F is tensile force, and $A = \pi r^2$ is the cross-section of the bar.

The strain is

$$\varepsilon = \frac{\Delta L}{L}$$

From given

$$\Delta L = L * \frac{100.1\%}{100\%}$$

Thus, the strain is

$$\varepsilon = \frac{\Delta L}{L} = \frac{100.1}{100} = 1.001$$

The Young's modulus

$$E = \frac{F/A}{\varepsilon}$$

Combining Equations and solving for F, leads to,

$$F = \varepsilon E A = 1.001 * (1 * 10^{11}\text{N m}^{-2}) * \pi * (0.5 * 10^{-3}\ m)^2 = 78.6 * 10^3\ N$$

Answer: $78.6 * 10^3\ N$