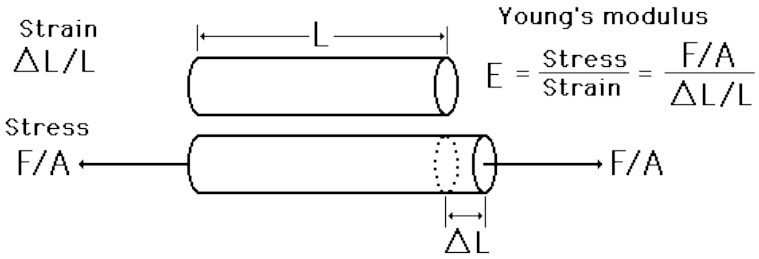
Answer on Question #70702, Physics / Mechanics

A copper wire of 3 cm length and 1 mm diameter is subjected to a tension of 5 N. Calculate the elongation produced in the wire if the young's modulus of elasticity of copper is 120 GPa.

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

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

where ΔL is elongation.

The Young's modulus

$$E = \frac{\sigma}{\varepsilon}$$

Combining Equations and solving for ΔL, leads to,

$$\frac{F}{A} = \frac{\Delta L}{L} E$$

$$\Delta L = \frac{FL}{AE} = \frac{FL}{\pi r^2 E}$$

$$\Delta L = \frac{(5\ N)(0.03\ m)}{\pi(0.5 \times 10^{-3}\ m)^2(120 \times 10^9\ Pa)} = 1.59 \times 10^{-6}\ m$$

Answer: $1.59 \times 10^{-6}\ m$.