

A steel rod, 5 m long, has a diameter of 4 mm. The wire stretches 3 mm when it bears a load. Young's modulus for steel is $2.0 \times 10^{11} \text{ N/m}^2$. What is the mass of the load ?

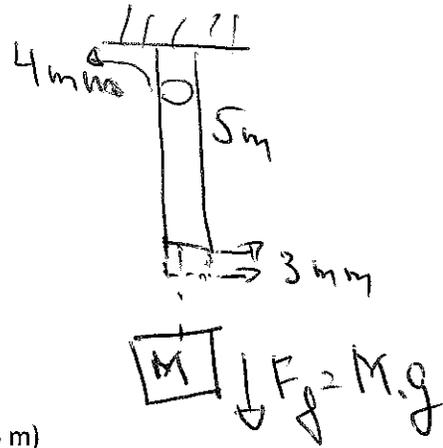
$$F/A = Y \cdot \Delta L/L$$

$$(M \cdot g)/(\pi d^2/4) = (2.0 \times 10^{11} \text{ N/m}^2) \times (3 \times 10^{-3} \text{ m})/(5 \text{ m})$$

$$(M \times 9.82 \text{ m/s}^2)/[3.14 \times (4 \times 10^{-3} \text{ m})^2/4] = (2.0 \times 10^{11} \text{ N/m}^2) \times (3 \times 10^{-3} \text{ m})/(5 \text{ m})$$

$$M = [3.14 \times (4 \times 10^{-3} \text{ m})^2 / 4] \times (2.0 \times 10^{11} \text{ N/m}^2) \times (3 \times 10^{-3} \text{ m}) / (9.82 \text{ m/s}^2 \times 5 \text{ m})$$

$$M = 153 \text{ kg}$$



A CYLINDRICAL METAL ROD 1 CM IN DIAMETER AND 25 CM LONG IS COMPRESSED BY 0.1 MM WHEN A FORCE OF 4.7 kN IS APPLIED. WHAT IS YOUNG'S MODULUS FOR THIS MATERIAL ?

Stress and strain relate as:

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

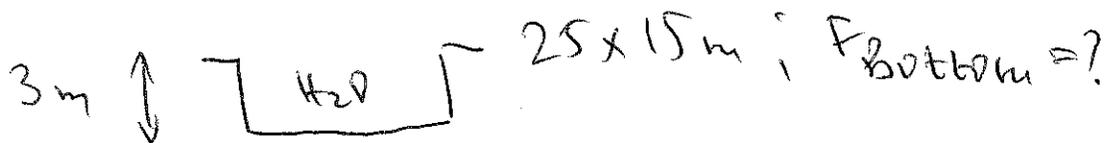
Rewriting this equation to calculate the Young's modulus gives:

$$Y = \frac{F L}{A \Delta L} = \frac{F L}{\frac{\pi}{4} d^2 \Delta L} = \frac{(4.7 \text{ kN}) (25 \text{ cm})}{\frac{\pi}{4} (1.0 \text{ cm})^2 (0.10 \text{ mm})} = 15 \times 10^{10} \text{ N/m}^2$$

$$1 \text{ cm} = 10^{-2} \text{ m}$$

$$1 \text{ mm} = 10^{-3} \text{ m}$$

$$1 \text{ "k"} = "10^3"$$



- 44. ORGANIZE AND PLAN** The water exerts a force on the bottom of the pool equal to its pressure times the area of the bottom of the pool. The pressure can be calculated from Equation 10.4.

Known: $h = 3.0$ m; $A = (25 \text{ m}) \times (15 \text{ m}) = 3.8 \times 10^2 \text{ m}^2$; $P_0 = 1$ atm; $\rho = 1000 \text{ kg/m}^3$.

SOLVE The pressure at the bottom of the pool is:

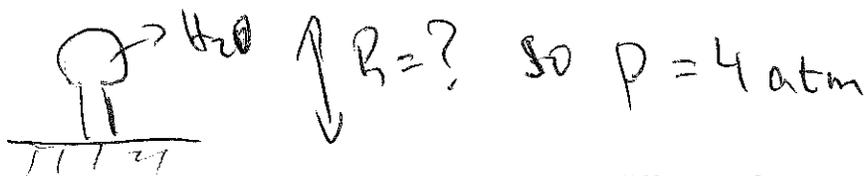
$$P = P_0 + \rho gh = (1 \text{ atm}) + (1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)(3.0 \text{ m}) = 1.3 \times 10^5 \text{ Pa}$$

The force is:

$$F = PA = (1.3 \times 10^5 \text{ Pa})(3.8 \times 10^2 \text{ m}^2) = 4.9 \times 10^7 \text{ N}$$

\rightarrow Area

REFLECT At this relatively shallow depth, most of the pressure (and most of the force) still comes from the atmospheric pressure.



42. **ORGANIZE AND PLAN** A gauge pressure is the pressure difference from atmospheric pressure and equals the height of a column of liquid times the density of the liquid times g .

Known: $\Delta P = 4 \text{ atm}$; $\rho = 1000 \text{ kg/m}^3$.

SOLVE The height of the water tower should be:

$$\Delta P = \rho g h$$

$$h = \frac{\Delta P}{\rho g} = \frac{(4 \text{ atm})}{(1000 \text{ kg/m}^3)(9.80 \text{ m/s}^2)} = 4 \times 10^1 \text{ m}$$

$$4 \times 10^5 \text{ Pa}$$