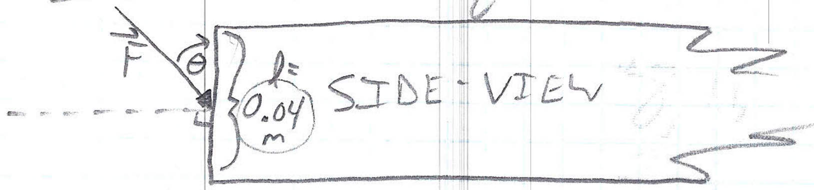
A.P. Hmwk: Ch. 9 #'s 8, 11, 17, 40; 44.

[8] Stress on square bar.



$\theta = 37°$

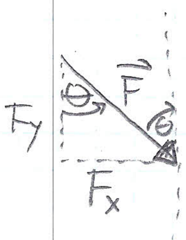
$|\vec{F}| = 250\,N$

$A = l \times w = 0.0016\,m^2$

(a) Compressional (along the length of) stress = ?

(b) shear (angular) stress = ?

(a) Consider component along the bar ($\hat{x}$-direction)



$F_x = F \cdot \sin\theta \longrightarrow S_{tress_x} = \frac{F_x}{A} = \frac{F \cdot \sin\theta}{A} = \boxed{94{,}033.6\,\frac{N}{m^2}}$

(b) $F_y = F \cdot \cos\theta \longrightarrow S_{tress_y} = \frac{F_y}{A} = \frac{F \cdot \cos\theta}{A} = \boxed{124{,}786.8\,\frac{N}{m^2}}$

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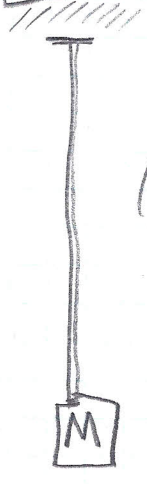
[11] ΔL Cu-wire by tensional stress

(be careful, we were given diameter !! ;))



$L_0 = 5m$, $A = \pi r^2$ (where $r = 0.0015\,m$) $\therefore A = 7.065E-6\,m^2$

when will $\Delta L = 0.0003m$ (ie, when will $\frac{\Delta L}{L_0} = 6E-5$?)

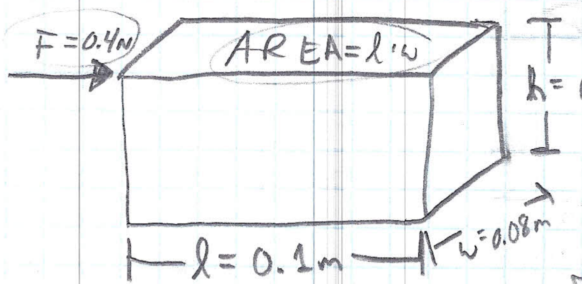
(Young's Modulus) $Y_{Cu} = 11 \times 10^{10}\,\frac{N}{m^2}$

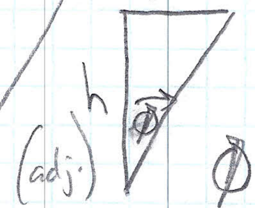
$$\frac{F}{A} = Y\left(\frac{\Delta L}{L_0}\right) \Rightarrow F = Y\left(\frac{\Delta L}{L_0}\right)A$$

$$F = \left(11 \times 10^{10}\,\frac{N}{m^2}\right)(6E-5)(7.065E-6\,m^2) = \boxed{46.63\,N}$$

17 Gelatin and shear-force

NOTE: we use RADIANS for ϕ!





$\phi = \tan^{-1}\left(\frac{\Delta X}{h}\right)$

$\phi = 0.0074998$

"small angle approximation"

(NOTE: $\frac{x}{h} = 0.0075$)

$S = ?$

$A = 0.008 m^2$

$$S = \frac{F/A}{x/h} \rightarrow \frac{0.4N \div (l \times w)}{0.0075} = \boxed{6666.67 \frac{N}{m^2}}$$

40 Pascal's Barrel Demonstration

ⓐ $F_{g,\text{water in tube}} = ?$

ⓑ Pressure applied to lid = ?

ⓒ F_{net} on lid = ?

Recall: $\left(\rho_{H_2O} \approx \frac{1000\ kg}{m^3}\right)$

ⓐ $F_{g,water} = m \cdot g = \rho_{H_2O} \cdot V_{H_2O} \cdot g$

$\rho \equiv M/V$ ∴ $M = \rho \cdot V$

$V_{cylinder} = \pi r^2 \cdot h = A \cdot h$

$V_{tube} = (5E-5 m^2)(12m) = 0.0006\ m^3$

$F_{g,H_2O} = \left(1000\frac{kg}{m^3}\right)(0.0006 m^3)(9.8 m/s^2) = \boxed{5.88N}$ (very little weight)

ⓑ $P = F/A$ (Pressure on lid same as pressure applied to "bottom of tube" (water))

$$P_{H_2O} = \frac{5.88N}{5E-5 m^2} = \boxed{117600 \frac{N}{m^2}}$$ (greater than an atmosphere)

⟹

C $F_{net} = ?$ $P = \frac{F}{A}$

$A = 0.2\,m^2$

$F = A \cdot P = (0.2\,m^2)(117600\,\frac{N}{m^2}) = \boxed{235200\,N}$

(exactly 4000 times greater than the weight of the water!)

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44 Hydraulic Press $A_{out} = 0.2\,m^2$ $d = 0.05\,m$ ($\therefore r = 0.025\,m$)

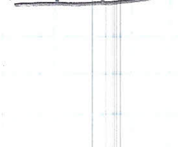
(a) $P_{in} = ?$ (such that $F_{out} = 1.5E6\,N$ (to lift that load...))

(b) $F_{in} = ?$ ($A_{in} = \pi r^2 = 1.96E-3\,m^2$)

(a) $P_{in} = P_{out}$ (Pascal's Principle) ← KEY

$P_{out} = \frac{F_{out}}{A_{out}} = \frac{1.5E6\,N}{0.2\,m^2} = \boxed{7{,}500{,}000\,\frac{N}{m^2}} = P_{in}$ (~75 atm)

(b) $F_{in} = ?$



$\therefore F_{in} = P_{in} \cdot A_{in} = (7.5E6\,\frac{N}{m^2})(1.96E-3\,m^2)$

$F_{in} = \boxed{14700\,N}$

(over 100 times less force required)

think "Hydraulic Jack to lift a car to change tire"