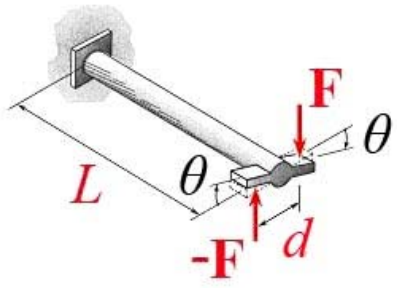
MEEG 2003 Quiz #1.m03.073

1. (3 points) The angle of twist (in radians) of an aluminum circular shaft, as shown, is given by $\theta = TL/(JG)$, where $T = Fd$, F = 300 lb, d = 2 in., L = 300 mm, $J = 10^4$ mm^4, and $G = 3.7 \times 10^6$ psi. Determine the value of θ in degrees.



2. (3 points) Using *chain-link conversion* strategy and 1 lbm = 0.4536 kg, convert the gas pressure of p = 150 kPa into psi.

3. (4 points) Describe the *rigid-body principle*.

1.
$$\theta = \frac{(Fd)L}{JG} = \frac{300\ \text{lb}\cdot 2\ \text{in.}\cdot 300\ \text{mm}}{10^4\ \text{mm}^4\cdot 3.7\times 10^6\ \text{psi}}\ \text{rad}\cdot\frac{1\ \text{psi}}{1\ \text{lb/in}^2}\cdot\frac{1^3\ \text{ft}^3}{(12)^3\ \text{in}^3}$$
$$\cdot\frac{(0.3048)^3\ \text{m}^3}{1^3\ \text{ft}^3}\cdot\frac{(10^3)^3\ \text{mm}^3}{1^3\ \text{m}^3}\cdot\frac{180^\circ}{\pi\ \text{rad}} = 4.5677^\circ$$
$$\therefore\ \theta = 4.57^\circ$$

2.
$$p = 150\ \text{kPa}\cdot\frac{10^3\ \text{Pa}}{1\ \text{kPa}}\cdot\frac{1\ \text{N/m}^2}{1\ \text{Pa}}\cdot\frac{1\ \text{kg}\cdot\text{m/s}^2}{1\ \text{N}}\cdot\frac{(0.3048)^2\ \text{m}^2}{1^2\ \text{ft}^2}$$
$$\cdot\frac{1\ \text{lbm}}{0.4536\ \text{kg}}\cdot\frac{1\ \text{lb}}{1\ \text{lbm}\cdot 9.81\ \text{m/s}^2}\cdot\frac{1^2\ \text{ft}^2}{(12)^2\ \text{in}^2}\cdot\frac{1\ \text{psi}}{1\ \text{lb/in}^2}$$
$$= 21.748\ \text{psi}$$
$$\therefore\ p = 21.7\ \text{psi}$$

3. The *rigid-body principle* states that if two collinear forces equal in magnitude but opposite in direction are applied to a rigid body, the condition of rest or motion of this rigid body will remain unchanged.