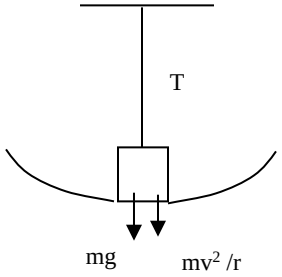
Tutorial Sheet 9. 2020/21
Mechanical Properties of Matter

1. A force of 20N is applied to the ends of a wire 4m long, and produces an extension of 0.24mm. If the diameter of the wire is 2mm, calculate the stress on the wire, its strain, and the value of the Young modulus. [$6.37\times10^{6}\ \mathrm{N/m^2}$, 6×10^{-5}, $1.06\times10^{11}\ N/m^2$]

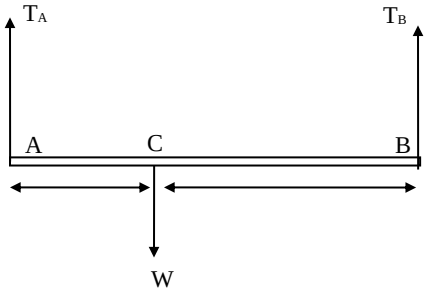
2. A 15 kg mass fastened to the end of a steel wire of un-stretched length 0.5 m is whirled in a vertical circle with an angular velocity of 2 rev/s at the bottom of the circle. The cross section of the wire is 0.02 cm^2. Calculate the elongation of the wire when the weight is at the lowest point of the path. Steel has Y.M.= 2.0 $\times$ 10^{11} Pa. [1.66mm]



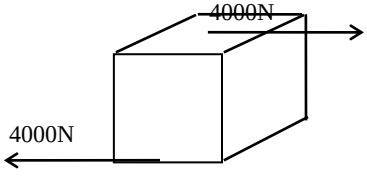
3. A rod 1.05 m long is hanging from 2 wires *A* & *B*. A weight *W* is hanging from the rod by a wire. The cross-sectional area of wire *A* = 1mm^2, and that of wire *B* = 4mm^2.

Where, measured from *A*, should the wire holding *W* be hung so that there is: (a) equal stress in the two wires, (b) equal strain in the two wires? Given Y_A = 2.4 $\times$ 10^{11} Pa and Y_B = 1.2 $\times$ 10^{11} Pa.

[(a) $0.84m$ *from A* (b) $0.7m$ *from A*]



4. Two parallel and opposite forces, each of 4000 N, are applied tangentially to the upper and lower faces of a cubical metal block 25 cm on each side. Find the angle of shear, and the displacement of the upper surface relative to the lower surface. Shear modulus for the metal is 0.80 $\times$ 10^{11} Pa [$\phi\approx8\times10^{-7}$, 2.0×10^{-7} m]



5. A glass tube is bent into a U-shape and water is poured into the tube until it stands 15 cm high in each side. A 3 cm column of alcohol is slowly poured into one side; the

two liquids do not mix. How far will the water column in the other side rise? Given, density of alcohol = 720 kg/m^3, and that of water = 1000 kg/m^3. [1.32 cm]

6. A copper wire *LM* is fused at one end, M, to an iron wire MN. The copper wire has length 0.900 m and cross-section 0.90×10^{-6} m^2. The iron wire has length 1.400 m and cross-section 1.30×10^{-6} m^2. The compound wire is stretched; its total length increases by 0.0100 m.

Calculate:

(a) the tension applied to the compound wire (b) the extension of each wire
(c) the ratio of the extensions of the two wires

[Y.M. of copper = 1.30×10^{11} Pa. Y.M. of iron = 2.10×10^{11} Pa.]

[F = 780N, $\Delta L_c = 6\text{mm}, \Delta L_i = 10 - 6 = 4\text{mm}$, Ratio $c : i = 1.5 : 1$]

7. A solid weighs 237.5 g in air and 12.5 g in a liquid in which it is wholly submerged. The density of the liquid is 900 kg/m^3.
Calculate (i) the density of the solid (ii) the density of another liquid in which the same solid would float with one-fifth of its volume exposed above the liquid surface.

[(i) $950 kg/m^3$ (ii) $1187.5 kg/m^3$]

8. Figure shows the essential parts of a hydraulic brake system. The area of the piston in the master cylinder is 6.4 cm^2, and that of the piston in the brake cylinder is 1.8 cm^2. The coefficient of friction between shoe and wheel drum is 0.5. If the wheel has a radius of 34 cm, determine the frictional torque about the axle when a force of 44 N is exerted on the brake pedal. [2.18 N-m]