

## PHY 2811 (2009)

### Solution of Exp. 5 prelab questions

1. Given:  $M = 1.5$  kg,  $\ell = 5.0$  cm,  $d = 5.0$  cm,  $m = 50$  g,  $\Delta\theta = 0.10^\circ$ .
- What is the period  $T$ ?
  - What is the torsional constant?
  - If a phosphor bronze wire of 15 cm long has been used for the torsional balance, what is the diameter of the wire?

Ans: (i) 
$$\Delta\theta = \frac{GMT^2}{2\pi^2 d^2 \ell}$$

$$\Rightarrow T = \sqrt{\frac{2\pi^2 d^2 \ell \theta}{GM}}$$

$$\Rightarrow T = \sqrt{\frac{2\pi^2 0.05^2 \times 0.1 \times \pi / 180}{6.67 \times 10^{-11} \times 1.5}}$$

$$\Rightarrow T = 207 \text{ sec}$$

(ii) 
$$I = 2m\ell^2$$

$$K = 4\pi^2 \frac{I}{T^2}$$

$$\Rightarrow K = 8\pi^2 \frac{m\ell^2}{T^2}$$

$$\Rightarrow K = 2.29 \times 10^{-7} \text{ Nm}$$

- (iii)  $\mathbf{G} = 4.3 \times 10^{10}$  N / m<sup>2</sup> is the shear modulus of phosphor bronze (Note: We have two almost identical symbols here:  $G$  and  $\mathbf{G}$ .)

$$K = \mathbf{G} \frac{\pi a^4}{2\ell}$$

$$\Rightarrow a = \sqrt[4]{\frac{2K\ell}{\pi\mathbf{G}}}$$

$$\Rightarrow a = \sqrt[4]{\frac{2 \times 2.29 \times 10^{-7} \times 0.15}{\pi \times 4.3 \times 10^{10}}}$$

$$\Rightarrow a = 2.67 \times 10^{-5} \text{ m}$$

where  $\ell = 15$  cm = length of the wire.

Diameter =  $5.34 \times 10^{-5}$  m.