

**INSTRUCTION:** ATTEMPT ALL THE QUESTIONS.

THIS WILL ACCOUNT FOR 10% OF THE FINAL GRADES

MAKE SURE YOU HAVE A WORKING SCIENTIFIC CALCULATOR

**TIME:** ONE HOUR

**QUESTION 1.**

- (a) Show that the non-zero principal moment of inertia of a uniform rigid rod of mass  $M$  and length  $L$  about either end is  $I = \frac{1}{3}ML^2$ .

**QUESTION 2.**

- (b) A *compound pendulum* is constructed by pivoting the rigid rod in part (a) about one end at the origin  $O$ . The rod swings freely in a vertical plane under gravity. If  $\theta$  denotes the angle the rod makes with the vertical, show that the kinetic energy of the rod is

$$T = \frac{1}{6}ML^2\dot{\theta}^2.$$

Show that the frequency of small oscillations about the point of stable equilibrium is  $\omega = \sqrt{3g/2L}$ . How does this compare with a simple pendulum of the same mass and length?