

STEP III, 2012 Q9

- 9 A pulley consists of a disc of radius r with centre O and a light thin axle through O perpendicular to the plane of the disc. The disc is non-uniform, its mass is M and its centre of mass is at O . The axle is fixed and horizontal.

Two particles, of masses m_1 and m_2 where $m_1 > m_2$, are connected by a light inextensible string which passes over the pulley. The contact between the string and the pulley is rough enough to prevent the string sliding. The pulley turns and the vertical force on the axle is found, by measurement, to be $P + Mg$.

- (i) The moment of inertia of the pulley about its axle is calculated assuming that the pulley rotates without friction about its axle. Show that the calculated value is

$$\frac{((m_1 + m_2)P - 4m_1m_2g)r^2}{(m_1 + m_2)g - P}. \quad (*)$$

- (ii) Instead, the moment of inertia of the pulley about its axle is calculated assuming that a couple of magnitude C due to friction acts on the axle of the pulley. Determine whether this calculated value is greater or smaller than (*).

Show that $C < (m_1 - m_2)rg$.



NextStepMaths.com

To view mark schemes, fully worked solutions and examiner's comments, and for more details about tutoring and other services offered, go to NextStepMaths.com