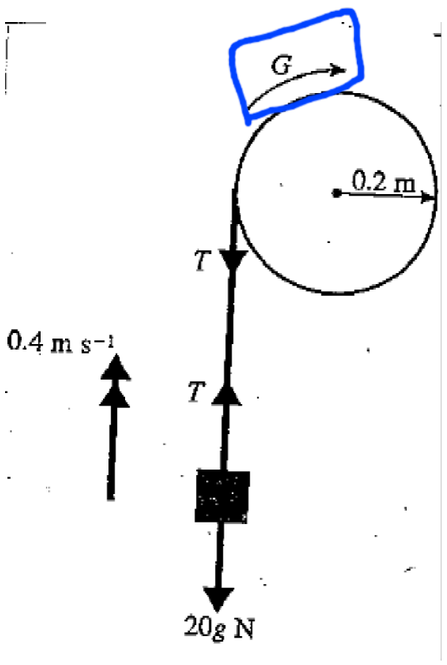
Further examples- L4

1. A load of mass 20 kg is being raised on the end of a light inextensible rope by means of a winch. The pulley of the winch has radius 20cm and MI 2.5 kgm^2. The pulley bearing is assumed to be smooth. The load starts from rest and accelerates at a rate of 0.4ms^{-2}. Find,
   a) The torque driving the pulley
   b) The kinetic energy of the system after 3 seconds.



$v = r\omega \quad \omega = 6$

KE of pulley + load

a) Load

$T - 20g = 2a \quad (a = 0.4)$

$T = 208N$

Net torque

$G - T(0.2) = I\alpha$

$G = 2.5\left(\frac{a}{r}\right) + 41.6 = 46.6Nm$

b) Load

$v = 0.4(3) = 1.2$

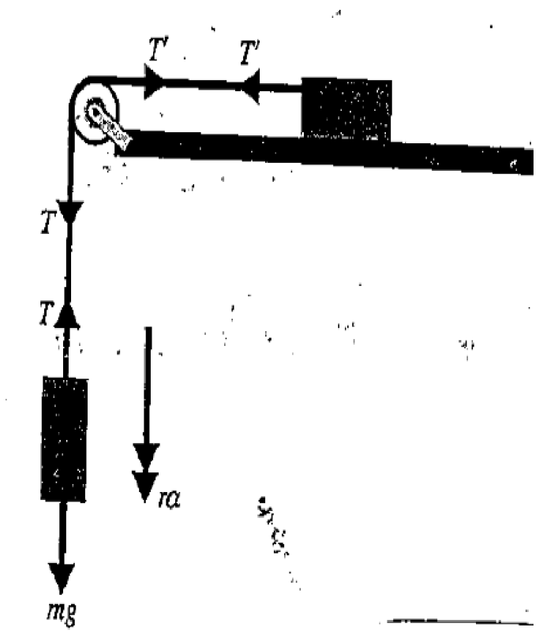
$\frac{1}{2}mv^2 = 14.45$

Pulley

$\frac{1}{2}I\omega^2 = 4.5$

$\therefore KE = 59.4J$

2. The diagram shows two particles, each of mass *m*, connected by a light, inextensible string. One particle rests on a smooth horizontal table. The other is suspended on a string, which passes over a pulley of radius *r* at the edge of the table. The MI of the pulley is $6mr^2$. The system is released from rest. Assuming that the pulley can rotate freely, and that the contact between the string and the pulley is rough, find the angular acceleration of the pulley.



$mg - T_1 = ma$

$T_2 = ma$

$mg - T_1 = T_2$

$T_1 = mg - T_2$

$(T_1 - T_2)r = 6mr^2\left(\frac{a}{r}\right)$

$mg - 2T_2 = 6mr\left(\frac{a}{r}\right)$

$\frac{a}{r} = \frac{mg - 2ma}{6mr}$

$6a = 10 - 2a$

$8a = 10$

$a = \frac{10}{8}$

$\alpha = \frac{a}{r} = \frac{\frac{10}{8}}{r} = \frac{1.25}{r}$ rads^{-2}