

## STEP III, 2012 Q9 MS

9. Eliminating  $T_1, T_2, a$ , and  $\alpha$  between the five equations  $m_1g - T_1 = m_1a$ ,  $T_1r - T_2r = I\alpha$ ,  $T_2 - m_2g = m_2a$ ,  $\alpha = \frac{a}{r}$ , and  $P + Mg = Mg + T_1 + T_2$  yields the required result for  $I$ . The only difference in the second part is that the second equation becomes  $T_1r - T_2r - C = I\alpha$ , and so the same elimination yields  $I = \frac{((m_1+m_2)P - 4m_1m_2g)r^2 - (m_1-m_2)Cr}{(m_1+m_2)g - P}$ , which can be seen to be smaller than that in part (i). The first four equations in this second part give  $m_1g - m_2g - \frac{C}{r} = \left(m_1 + m_2 + \frac{I}{r^2}\right)a$ , and so as  $a > 0$ , the required result follows.



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