

STEP II, 2005, Q11

- 11 A plane is inclined at an angle $\arctan \frac{3}{4}$ to the horizontal and a small, smooth, light pulley P is fixed to the top of the plane. A string, APB , passes over the pulley. A particle of mass m_1 is attached to the string at A and rests on the inclined plane with AP parallel to a line of greatest slope in the plane. A particle of mass m_2 , where $m_2 > m_1$, is attached to the string at B and hangs freely with BP vertical. The coefficient of friction between the particle at A and the plane is $\frac{1}{2}$.

The system is released from rest with the string taut. Show that the acceleration of the particles is $\frac{m_2 - m_1}{m_2 + m_1}g$.

At a time T after release, the string breaks. Given that the particle at A does not reach the pulley at any point in its motion, find an expression in terms of T for the time after release at which the particle at A reaches its maximum height. It is found that, regardless of when the string broke, this time is equal to the time taken by the particle at A to descend from its point of maximum height to the point at which it was released. Find the ratio $m_1 : m_2$.

[Note that $\arctan \frac{3}{4}$ is another notation for $\tan^{-1} \frac{3}{4}$.]



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