STEP II, 2005, Q11 MS

Q11 Again, good supporting diagrams will enhance success with this question. The first result is standard. Beyond that, the motion of A up and down the slope need to be considered separately.

Let u be the velocity when the string breaks and T_1 be the time from this instant to when the particle A reaches its highest point. Thus $u = \lambda g T$, where $\lambda = (m_2 - m_1)/(m_2 + m_1)$, and as the deceleration of A during the time T_1 is g, then $T_1 = \lambda T$. Hence the total time taken by P to reach the highest point is $(1 + \lambda)T$.

For the downward motion of A, the acceleration is $g/10$, so that the data given in the penultimate sentence of the question implies

$$(g/10)(1 + \lambda)^2 T^2 = (\lambda g/2)T^2 + (\lambda^2 g/2)T^2.$$

From this it follows that $\lambda = 1/4$ and hence that $m_1/m_2 = 3/5$.