

STEP III, 2013 , Q10 MS

10. The initial result can be obtained in a number of different ways, but probably use of the parallel axes rule is the simplest. Conserving angular momentum about P,

$mu(a + x) = mv(a + x) + \frac{1}{3} M(a^2 + 3x^2)\omega$ where v is the velocity of the particle after impact, and ω is the angular velocity of the beam after the impact, and by Newton's experimental law of impact $(a + x)\omega - v = eu$. **Eliminating** v between these two equations gives the quoted expression for ω . Substituting $m = 2M$, for maximum ω , $\frac{d\omega}{dx} = 0$. This gives a quadratic equation, with solutions $x = -\frac{1}{3}a$ and $x = -\frac{5}{3}a$. The latter is not feasible and the former can be shown to generate a maximum which equates to the given result.



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