

STEP III, 2005, Q10

- 10 Two thin discs, each of radius r and mass m , are held on a rough horizontal surface with their centres a distance $6r$ apart. A thin light elastic band, of natural length $2\pi r$ and modulus $\frac{\pi mg}{12}$, is wrapped once round the discs, its straight sections being parallel. The contact between the elastic band and the discs is smooth. The coefficient of static friction between each disc and the horizontal surface is μ , and each disc experiences a force due to friction equal to μmg when it is sliding.

The discs are released simultaneously. If the discs collide, they rebound and a half of their total kinetic energy is lost in the collision.

- (i) Show that the discs start sliding, but come to rest before colliding, if and only if $\frac{2}{3} < \mu < 1$.
- (ii) Show that, if the discs collide at least once, their total kinetic energy just before the first collision is $\frac{4}{3}mgr(2 - 3\mu)$.
- (iii) Show that if $\frac{4}{9} > \mu^2 > \frac{5}{27}$ the discs come to rest exactly once after the first collision.



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