

STEP III, 2008 Q11

- 11 A circular wheel of radius r has moment of inertia I about its axle, which is fixed in a horizontal position. A light string is wrapped around the circumference of the wheel and a particle of mass m hangs from the free end. The system is released from rest and the particle descends. The string does not slip on the wheel.

As the particle descends, the wheel turns through n_1 revolutions, and the string then detaches from the wheel. At this moment, the angular speed of the wheel is ω_0 . The wheel then turns through a further n_2 revolutions, in time T , before coming to rest. The couple on the wheel due to resistance is constant.

Show that

$$\frac{1}{2}\omega_0 T = 2\pi n_2$$

and

$$I = \frac{mgrn_1T^2 - 4\pi mr^2n_2^2}{4\pi n_2(n_1 + n_2)}.$$



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