

A ball of mass  $m$  is attached to a string of length  $L$ . The ball is traveling with an angular velocity  $\omega$  in a horizontal plane.

(a) What is the kinetic energy of the ball in terms of  $\omega$ ,  $m$  and  $L$ ?

(b) What is the momentum of the ball in terms of  $m$ ,  $\omega$  and  $L$ .

Now let the string be cut and the ball flies off and has a completely inelastic collision with a mass  $m$  (which is the same).

(c) What is the velocity of the mass combination after the collision in terms of  $\omega$ ,  $m$  and  $L$ ?

(d) What is the kinetic energy of the mass combination after the collision in terms of  $\omega$ ,  $m$  and  $L$ ?

(e) Provide numerical answers with correct SI units for the case  $m=1$  kg,  $L = 1$  m and  $\omega=10$  "rad"/s.

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$$(a) \quad \omega = 2\pi f = \frac{2\pi}{T} \Rightarrow T = \frac{2\pi}{\omega} : s = 2\pi L : v_t = \frac{s}{T} = \frac{2\pi L}{\left[\frac{2\pi}{\omega}\right]} = \omega L : K = \frac{1}{2} m v_t^2 \Rightarrow K = \frac{1}{2} m (\omega L)^2$$

$$(b) \quad v_t = \omega L : p = mv = m\omega L$$

$$(c) \quad p_{\text{before}} = p_{\text{after}} \Rightarrow m v_{\text{before}} = 2m v_{\text{after}} \Rightarrow v_{\text{after}} = \frac{1}{2} v_{\text{before}} = \frac{1}{2} \omega L$$

$$(d) \quad K_{\text{after}} = \frac{1}{2} (2m) \left[ \frac{1}{2} \omega L \right]^2 = \frac{1}{4} m (\omega L)^2$$

$$(e) \quad K=50.0 \text{ J} : v=10 \text{ kg m/s} : v=5 \text{ m/s} : K=25.0 \text{ J}$$