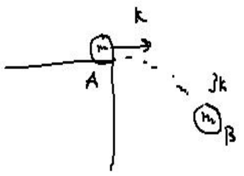
(12)



$\Delta KE = 2K$

$v_{f_y} = gt \qquad 2K = \frac{1}{2} m g^2 t^2$

$v_{f_y}^2 = g^2 t^2 \qquad 4K = m g^2 t^2$

$t = \frac{2}{g}\sqrt{\frac{K}{m}} \qquad \frac{4K}{mg^2} = t^2$

(13) Loss of GPE = gain KE

$v = r\omega$

$mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$

$\cancel{m} gh = \frac{1}{2} \cancel{m} v^2 + \frac{1}{\cancel{2}}\left(\frac{2}{5}\cancel{m}\cancel{r^2}\right)\left(\frac{v}{\cancel{r}}\right)^2$

$gh = \frac{1}{2} v^2 + \frac{1}{5} v^2$

$gh = \frac{7}{10} v^2$

$v^2 = \frac{10}{7} gh$

$v_f^2 = v_i^2 \pm 2ad$

$0 = \frac{10}{7} gh \mp 2gd$

$2d = \frac{10}{7} h$

$d = \left(\frac{5}{7}\right) h$

(16) KE cons. $\frac{1}{2} m v_0^2 = \frac{1}{2} m v_1'^2 + \frac{1}{2} M v_2'^2 \Rightarrow$

$\vec{p}$ cons $m v_0 = m v_1' + M v_2'$

~~solve for~~ $v_1' = ?$ Let's try CoM frame

Don't even try 2 eq. 2 unknowns!!

$v_{cm} = \frac{m v_0 + 0}{m + M} = \frac{m v_0}{m + M}$

$v_{1cm} = v_0 - \frac{m v_0}{m + M} = v_0\left(1 - \frac{m}{m + M}\right) = v_0\left(\frac{m + M - m}{m + M}\right)$

$v_{1cm} = \frac{v_0 M}{m + M}$

$v_{1cm}' = \frac{-v_0 M}{m + M}$

$v_{1lab}' = v_{1cm}' + v_{cm} = \frac{-v_0 M}{m + M} + \frac{m v_0}{m + M} = \frac{(m - M) v_0}{m + M}$ (E)

(15) $KE_i = mgh + KE_{com}$

$\frac{1}{2} m v_0^2 = mgh + \frac{1}{2}(m + M) v_{cm}^2$

$\frac{1}{2} m v_0^2 = mgh + \frac{1}{2}(m + M)\left(\frac{m^2 v_0^2}{(m + M)^2}\right)$

$\frac{1}{2} m v_0^2 = mgh + \frac{m^2 v_0^2}{2(m + M)}$

$\frac{1}{2} m v_0^2 \left[1 - \frac{m}{m + M}\right] = mgh$

$\frac{1}{2} \cancel{m} v_0^2 \left[\frac{m + M - m}{m + M}\right] = \cancel{m} gh$

$\frac{v_0^2}{2g}\left[\frac{M}{m + M}\right] = h$ (C)