16. (a) The acceleration is given by Eq. 12-13:

$$a_{\text{com}} = -\frac{g}{1 + I_{\text{com}}/MR_0^2}$$

where upward is the positive translational direction. Taking the coordinate origin at the initial position, Eq. 2-15 leads to

$$y_{\text{com}} = v_{\text{com},0}\, t + \frac{1}{2}a_{\text{com}}t^2 = v_{\text{com},0}\, t - \frac{\frac{1}{2}gt^2}{1 + I_{\text{com}}/MR_0^2}$$

where $y_{\text{com}} = -1.2\,\text{m}$ and $v_{\text{com},0} = -1.3$ m/s. Substituting $I_{\text{com}} = 0.000095\,\text{kg}\cdot\text{m}^2$, $M = 0.12\,\text{kg}$, $R_0 = 0.0032\,\text{m}$ and $g = 9.8\,\text{m/s}^2$, we use the quadratic formula and find

$$\begin{aligned} t &= \frac{\left(1 + \frac{I_{\text{com}}}{MR_0^2}\right)\left(v_{\text{com},0} \mp \sqrt{v_{\text{com},0}^2 - \frac{2gy_{\text{com}}}{1+I_{\text{com}}/MR_0^2}}\right)}{g} \\ &= \frac{\left(1 + \frac{0.000095}{(0.12)(0.0032)^2}\right)\left(-1.3 \mp \sqrt{1.3^2 - \frac{2(9.8)(-1.2)}{1+0.000095/(0.12)(0.0032)^2}}\right)}{9.8} \\ &= -21.7 \quad \text{or} \quad 0.885 \end{aligned}$$

where we choose $t = 0.89$ s as the answer.

(b) We note that the initial potential energy is $U_i = Mgh$ and $h = 1.2$ m (using the bottom as the reference level for computing U). The initial kinetic energy is as shown in Eq. 12-5, where the initial angular and linear speeds are related by Eq. 12-2. Energy conservation leads to

$$\begin{aligned} K_f &= K_i + U_i \\ &= \frac{1}{2}mv_{\text{com},0}^2 + \frac{1}{2}I\left(\frac{v_{\text{com},0}}{R_0}\right)^2 + Mgh \\ &= \frac{1}{2}(0.12)(1.3)^2 + \frac{1}{2}\left(9.5 \times 10^{-5}\right)\left(\frac{1.3}{0.0032}\right)^2 + (0.12)(9.8)(1.2) \\ &= 9.4 \text{ J} . \end{aligned}$$

(c) As it reaches the end of the string, its center of mass velocity is given by Eq. 2-11:

$$v_{\text{com}} = v_{\text{com},0} + a_{\text{com}}t = v_{\text{com},0} - \frac{gt}{1 + I_{\text{com}}/MR_0^2} \quad .$$

Thus, we obtain

$$v_{\text{com}} = -1.3 - \frac{(9.8)(0.885)}{1 + \frac{0.000095}{(0.12)(0.0032)^2}} = -1.41 \text{ m/s}$$

so its linear speed at that moment is approximately 1.4 m/s.

(d) The translational kinetic energy is $\frac{1}{2}mv_{\text{com}}^2 = \frac{1}{2}(0.12)(1.41)^2 = 0.12\,\text{J}$.

(e) The angular velocity at that moment is given by

$$\omega = -\frac{v_{\text{com}}}{R_0} = -\frac{-1.41}{0.0032} = 441$$

or approximately 440 rad/s.

(f) And the rotational kinetic energy is

$$\frac{1}{2}I_{\text{com}}\omega^2 = \frac{1}{2}\left(9.50 \times 10^{-5}\,\text{kg}\cdot\text{m}^2\right)(441\,\text{rad/s})^2 = 9.2 \text{ J} .$$