99. (a) The potential energy at the turning point is equal (in the absence of friction) to the total kinetic energy (translational plus rotational) as it passes through the equilibrium position:

$$\begin{aligned}
\frac{1}{2}kx_m^2 &= \frac{1}{2}Mv_{\rm cm}^2 + \frac{1}{2}I_{\rm cm}\omega^2 \\
&= \frac{1}{2}Mv_{\rm cm}^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v_{\rm cm}}{R}\right)^2 \\
&= \frac{1}{2}Mv_{\rm cm}^2 + \frac{1}{4}Mv_{\rm cm}^2 = \frac{3}{4}Mv_{\rm cm}^2 \ .
\end{aligned}$$

which leads to $Mv_{\rm cm}^2 = 2kx_m^2/3 = 0.125$ J. The translational kinetic energy is therefore $\frac{1}{2}Mv_{\rm cm}^2 = kx_m^2/3 = 0.0625$ J.

(b) And the rotational kinetic energy is $\frac{1}{4}Mv_{\rm cm}^2 = kx_m^2/6 = 0.03125$ J.

(c) In this part, we use $v_{\rm cm}$ to denote the speed at any instant (and not just the maximum speed as we had done in the previous parts). Since the energy is constant, then

$$\begin{aligned}
\frac{dE}{dt} &= 0 \\
\frac{d}{dt}\left(\frac{3}{4}Mv_{\rm cm}^2\right)\frac{d}{dt}\left(\frac{1}{2}kx^2\right) &= 0 \\
\frac{3}{2}Mv_{\rm cm}a_{\rm cm} + kxv_{\rm cm} &= 0
\end{aligned}$$

which leads to

$$a_{\rm cm} = -\left(\frac{2k}{3M}\right)x \ .$$

Comparing with Eq. 16-8, we see that $\omega = \sqrt{2k/3M}$ for this system. Since $\omega = 2\pi/T$, we obtain the desired result: $T = 2\pi\sqrt{3M/2k}$.