1) Dissipates.
   1) Sound
   2) Heat

2) $\frac{18 \cdot 9.8}{(2\pi \cdot 1000)^2} \cdot \frac{1}{10} = \boxed{4.47 \times 10^{-7}}$

3) $\delta = \frac{1}{5} \ln 4 = .2773$

$$\zeta = \frac{\delta}{\sqrt{4\pi^2 + \delta^2}} = .0441$$

$$C = \zeta 2 \sqrt{km} = \zeta 2 mw = \boxed{4.41 \text{ kg/s}}$$

4) $T = \frac{1}{2} m \dot{x}^2 + \frac{1}{2} J \dot{\theta}^2 = \frac{1}{2} m \dot{x}^2 + \frac{1}{2} \frac{J}{r^2} \dot{x}^2$

$U = \frac{1}{2} k x^2 - mg x$

$$\frac{d}{dt} \frac{\partial T}{\partial \dot{U}} + \frac{\partial U}{\partial x} = 0$$

$$\left(m + \frac{J}{r^2}\right) \ddot{x} + kx = mg$$

5) $X_n(x) = A_n \sin \sigma_n x + B_n \cos \sigma_n x$

$X(0) = 0, \quad B = 0$

$X(l) = 0 = A \sin \sigma_n l$

$\sigma_n l = n\pi$

$\sigma_n = \frac{n\pi}{l}$

$w_n(x,t) = T(t) X_n(x)$

$w_{n_{tt}} = -\omega_n^2 T(t) X_n(x) \qquad w_{n_{xx}} = -\left(\frac{n\pi}{l}\right)^2 T(t) X_n(x)$

Substitute into EOM

$$\frac{E}{\rho} \left(\frac{n\pi}{l}\right)^2 = -\omega_n^2$$

$$\boxed{\omega_n = \frac{n\pi}{l} \sqrt{\frac{E}{\rho}}}$$

$$X_n(x) = A_n \sin \frac{n\pi x}{l}$$