Q 4.1.

First of all, the work is

$$W = \vec{F} \cdot \Delta\vec{r}_{cm} = F \cdot d$$

Since the total mass of the (disk + 2 small mass) is

$$M + 2M,$$

we can set up an equation for the point-particle system

$$\Delta E = W$$

$$K_f - K_i = W$$

$$\frac{1}{2}(M+2m)\,v^2 - 0 = F \cdot d$$

$$\boxed{\text{Answer: } v = \sqrt{\frac{2 \cdot F \cdot d}{M+2m}}}$$

Q 4.2

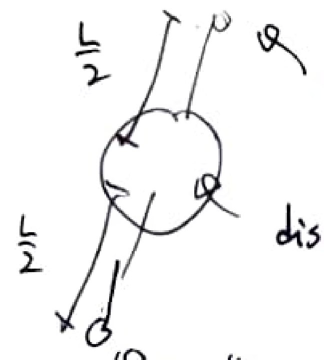
In the extended system, the work is

$$W = \underbrace{\vec{F} \cdot \Delta\vec{r}_{cm}}_{\text{for translational}} + \underbrace{\vec{F} \cdot \Delta\vec{r}_{\text{string change}}}_{\text{for rotational}}$$

$$= F \cdot d + F \cdot s.$$

$$= F \cdot (d+s)$$

Then, we need to know both K_{trans} and K_{rot}. Thus, we need $\frac{1}{2}I\omega^2$ and $\frac{1}{2}mv^2$ as follows



mass, $I = m\left(\frac{L}{2}\right)^2 = \frac{mL^2}{4}$ Therefore, we can write an equation as follows,

disk, $I = \frac{1}{2}MR^2$

mass, $I = m\left(\frac{L}{2}\right)^2 = \frac{mL^2}{4}$

$$\Delta E = W$$

initial, at rest $K_i = 0$.

$$K_{trans} + K_{rot} = F\cdot(d+s)$$

$$\frac{1}{2}(M+2m)v^2 + \frac{1}{2}\left(\frac{1}{2}MR^2 + \frac{1}{2}mL^2\right)\omega^2 = F\cdot(d+s)$$

Since $v = \frac{L}{2}\cdot\omega$,

$$\frac{1}{8}(M+2m)\cdot L^2\cdot\omega^2 + \frac{1}{4}MR^2\omega^2 + \frac{1}{4}mL^2\omega^2 = F\cdot(d+s)$$

$$\omega^2\left\{\frac{1}{8}(M+2m)\cdot L^2 + \frac{1}{4}MR^2 + \frac{1}{4}mL^2\right\} = F\cdot(d+s)$$

Answer:

$$\boxed{\omega = \sqrt{\frac{F\cdot(d+s)}{\frac{1}{8}ML^2 + \frac{1}{2}mL^2 + \frac{1}{4}MR^2}}}$$