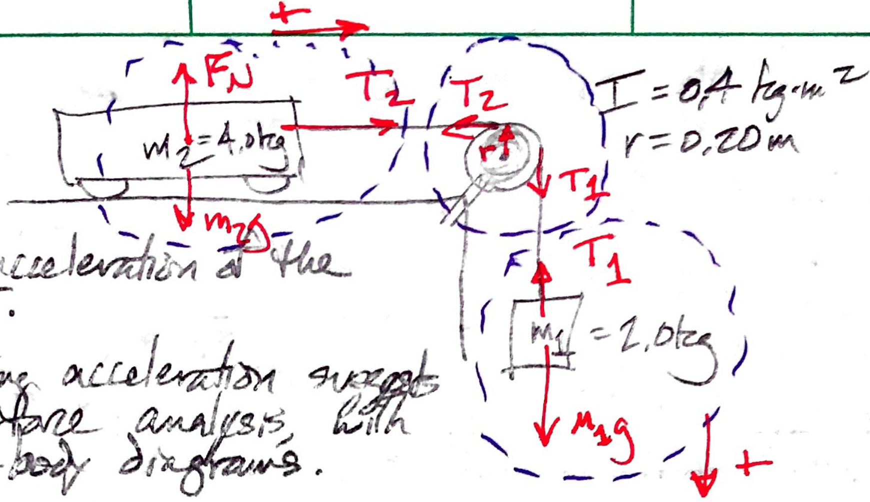
10.94



Find acceleration of the cart.

Finding acceleration suggests a force analysis, with free-body diagrams.

$$\Sigma F_2 = m a_2 \qquad \Sigma F_1 = m_1 a$$

$$T_2 = m_2 a \qquad m_1 g - T_1 = m_1 a$$

$$\Sigma \tau = I\alpha$$

$$rT_1 - rT_2 = I\frac{a}{r} \quad (\text{where } a = r\alpha)$$

$$r(m_1 g - m_1 a) - r(m_2 a) = (0.4)\frac{a}{r}$$

$$r m_1 g - r m_1 a - r m_2 a = \frac{0.4}{r} a$$

$$r m_1 g = \frac{0.4}{r} a + r m_1 a + r m_2 a$$

$$(0.2)(2)(9.8) = \frac{0.4}{0.2} a + (0.2)(2)a + (0.2)(4) a$$

$$3.92 = 2a + 0.4a + 0.8a$$

$$a = \boxed{1.23 \text{ m/s}^2}$$

10.100

m = 500 kg (!)
radius = 0.25 m

a) If starting from rest, how much Work done by force after 3 revolutions?

$$W = \Delta K = K_f - K_i = \frac{1}{2} I \omega^2$$

$$W = \int F \cdot dx \overset{or}{\rightarrow} \tau \cdot \theta!$$

$$= (r \times F)\, 3(2\pi \text{ rads})$$

$$= (0.25)(10N)(6\pi)$$

$$= \boxed{47.1 J}$$

b) Oh, looks like they're asking for this torque analysis here. Was I supposed to use energy analysis for part a?. I'll do it here:

$$\text{Work } W = \frac{1}{2} I \omega^2$$

$$\text{angular velocity } \omega^2 = \omega_i^2 + 2\alpha\theta$$

$$= 0 + 2\alpha(2\pi \cdot 3)$$

$$\tau = rF = I\alpha, \text{ so } \alpha = \frac{rF}{I}$$

$$\text{Angular vel: } \omega^2 = 2\left(\frac{rF}{I}\right)(6\pi), \text{ so}$$

$$\text{Work} = \frac{1}{2} I \left(2 \frac{rF}{I}\right) 6\pi = (0.25)(10)(6\pi) = \boxed{47.1 J}$$

it's the same!

c) $\omega^2 = \omega_i^2 + 2\alpha\theta$ (calculated above)

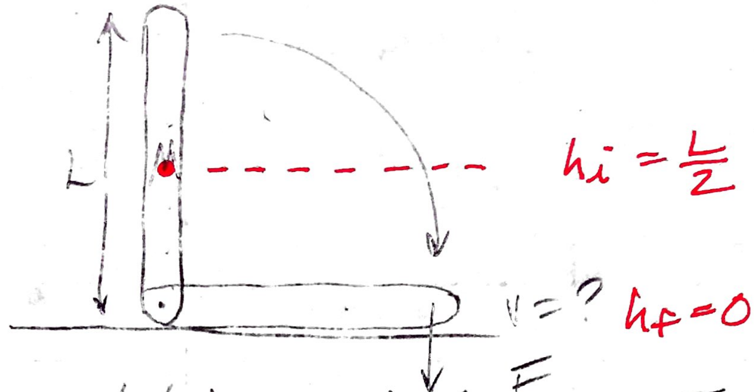
$$= \sqrt{\frac{2(0.25)(10)(6\pi)}{\frac{1}{2}(500)(0.25)^2}} \longleftarrow I_{disk} = \frac{1}{2} MR^2$$

$$= \boxed{2.46 \text{ rad/s}}$$

d) $P = \frac{dW}{dt} = F \cdot v \Rightarrow \tau \cdot \omega = rF\omega$

$$= (0.25)(10)(2.46) = \boxed{6.15 W}$$

10.103



They want to know velocity, so an Energy analysis seems appropriate. (Plus, acceleration isn't constant, so $\tau = I\alpha$ wouldn't be useful here.

Yes, definitely an Energy analysis!

$$\Sigma E_i = \Sigma E_f$$

$$K_i + U_{gi} = K_f + U_{gf}$$

$$0 + mgh = \frac{1}{2} I \omega^2 + 0$$

$$mg\frac{L}{2} = \frac{1}{2}\left(\frac{1}{3} m L^2\right)\omega^2$$

$$\omega = \sqrt{\frac{3g}{L}}$$

$$v = r\omega$$

$$= L\sqrt{\frac{3g}{L}}$$

$$= \sqrt{\frac{L^2 3g}{L}}$$

$$\boxed{v = \sqrt{3gL}}$$