13.28

$K_{rot} = \frac{1}{2} I \omega^2$

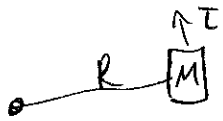
$= \frac{1}{2}\left(\frac{2}{5} M_e R_e^2\right) \omega_e^2$

$= \frac{1}{5}(6\cdot10^{24})(6\cdot10^6)^2(7.27\cdot10^{-5})^2$

$= 2.57\cdot10^{29}\ J$

$\omega = \frac{2\pi}{T} = \frac{2\pi}{24\,hrs} = 7.27\cdot10^{-5}$

13.43



$M = 200g \qquad I = MR^2$

$\tau = .05\ Nm$

$R = .40\ m$

$\tau = I\alpha$

$\alpha = \frac{\tau}{I} = \frac{.05}{(.200)(.4)^2} = 1.56\ rad/s^2$

a) $\theta = \frac{1}{2}\alpha t^2$

$\theta = 10\cdot 2\pi \Rightarrow 20\pi = \frac{1.56}{2} t^2 \rightarrow \boxed{t = 8.97s}$

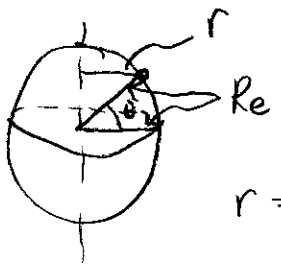
b) $L = I\omega$

$\omega = \alpha t$

$\Rightarrow L = I\alpha t = (.2)(.4)^2(1.56)\cdot(8.97) = \boxed{.448\ \frac{kgm^2}{s}}$

c) $\frac{\Delta L}{\Delta t} = \frac{.448}{8.97} = .05 = \tau$ ✓

13.48



$r = R_e \cos\theta$

a) $\theta = 26° \Rightarrow r = 6.37 \cdot 10^6 \cdot \cos 26 = 5,725\,10^6 m$

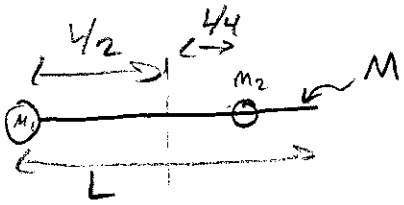
$\omega = \frac{2\pi}{T} = \frac{2\pi}{24 \cdot 3600} = 7.27 \cdot 10^{-5} \frac{rad}{s}$

$V = \omega r = 7.27 \cdot 10^{-5} \cdot 5.725 \cdot 10^6 = \boxed{416\ m/s}$

b) $\theta = 65° \Rightarrow r = 2.69 \cdot 10^6 m$

$V = \omega r = 7.27 \cdot 10^{-5} \cdot 2.69 \cdot 10^6 = \boxed{196\ m/s}$

13.54



$I_{total} = I_1 + I_2 + I_{rod}$

$I_1 = m_1\left(\frac{L}{2}\right)^2 = \frac{m_1 L^2}{4}$

$I_2 = m_2\left(\frac{L}{4}\right)^2 = \frac{m_2 L^2}{16}$

$\lambda = \frac{M}{L}$ $\quad dm = \lambda dx$ $\quad I = \int r^2 dm$

$I_{rod} = \int_{-L/2}^{L/2} x^2 \lambda\, dx = \frac{M}{L}\left.\frac{x^3}{3}\right|_{-L/2}^{L/2} = \frac{M}{L}\frac{L^3}{12} = \frac{ML^2}{12}$

$$\boxed{I_{total} = \frac{m_1 L^2}{4} + \frac{m_2 L^2}{16} + \frac{ML^2}{12}}$$

13.82

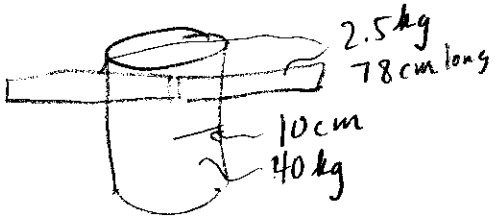
$I_{cylinder} = \frac{1}{2} MR^2$

$I_{rod} = \frac{1}{3} ML^2$ (about end)

$\omega_i = 1.5 \frac{rev}{s} \cdot 2\pi \frac{rad}{rev}$

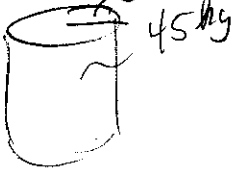
$= 9.42 \frac{rad}{s}$

initial



$I_i = \frac{1}{2}(40)(.1)^2 + 2 \cdot \frac{1}{3}(2.5)(.78)^2 = 1.214 \text{ kg m}^2$

final



$I_f = \frac{1}{2}(45)(.1)^2 = .225 \text{ kg m}^2$

$I_i \omega_i = I_f \omega_f$

$\omega_f = \frac{I_i \omega_i}{I_f} = \frac{(1.214)\cdot(9.42)}{.225} = 50.8 \frac{rad}{s}$

$f = \frac{\omega}{2\pi} = \frac{50.8}{2\pi} = \boxed{8.09 \frac{rev}{s}}$