9.72 $\theta = \theta_0 + \omega_{0z} t + \frac{1}{2} \alpha_z t^2$ $\omega_{0z} = 0$ since starting from rest

Consider $\theta_0 = 0$: $\theta_{2rev} = 2 \cdot 2\pi \Rightarrow$ 2nd revolution $\theta_{1rev} = 2\pi \Rightarrow$ 1st revolution

$\theta_{2rev} = 4\pi = \frac{1}{2} \alpha_z \cdot t_{2rev}^2$ $\theta_{1rev} = 2\pi = \frac{1}{2} \alpha_z t_{1rev}^2$

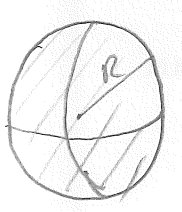
$$\frac{\theta_{2rev}}{\theta_{1rev}} = \frac{4\pi}{2\pi} = \left(\frac{t_{2rev}}{t_{1rev}}\right)^2 = 2 \Rightarrow t_{2rev} = \sqrt{2}\, t_{1rev}$$

It is given that $t_{2rev} - t_{1rev} = 0.75\,s \Rightarrow (\sqrt{2} - 1) t_{1rev} = 0.75\,s$

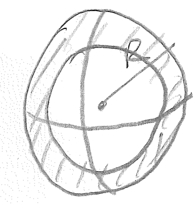
$$\underline{\underline{t_{1rev} = 1.81\,s}}$$

b) $\theta_{1rev} = 2\pi = \frac{1}{2} \cdot \alpha_z \cdot (1.81)^2 \Rightarrow \underline{\underline{\alpha_z = 3.84\,\text{rad}/s^2}}$

9.76



Solid sphere



hollow spherical shell

$$I_{solid} = \frac{2}{5} M_{solid} R^2 \qquad I_{hollow} = \frac{2}{3} M_{hollow} R^2$$

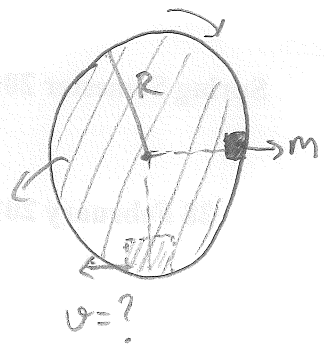
$$M_{solid} = M \qquad M_{hollow} = ?$$

$K = \frac{I}{2}\omega^2$ for $K_{solid} = K_{hollow}$ at any $\omega \Rightarrow I_{solid} = I_{hollow}$

$$\frac{2}{5} M R^2 = \frac{2}{3} M_{hollow} R^2$$

$$\underline{\underline{M_{hollow} = \frac{3}{5} M}}$$

9.78



Using energy conservation:

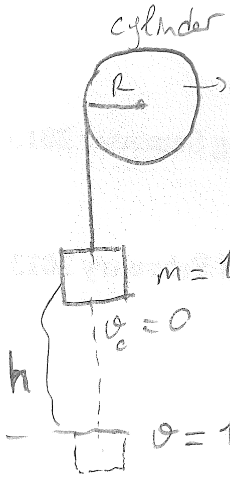
Initially: $E = mgR$ (Potential energy of small object)

Finally: $E = \frac{1}{2} I \omega^2$ (Rotational kinetic energy of both the disc & small object)

$$I = \underbrace{\frac{1}{2} m R^2}_{\text{disc}} + \underbrace{m R^2}_{\text{small object}} \Rightarrow \frac{1}{2} \cdot \frac{3}{2} \cancel{m} R^{\cancel{2}} \omega^2 = \cancel{m} g R$$

$$\omega^2 = \frac{4}{3} \frac{g}{R} \Rightarrow \omega = \sqrt{\frac{4g}{3R}}$$

9.89



$M = 10.0\,kg$

$R = \frac{30.0\,cm}{2} = \frac{0.3\,m}{2} = 0.15\,m$

$m = 12.0\,kg$

$v_0 = 0$

$v = 13.86\,m/s$

$K_{cyl} = \frac{1}{2} I \omega^2 = 480\,J \qquad I = \frac{1}{2} M R^2 = \frac{1}{2} \cdot 10 \cdot (0.15)^2 = 0.1125\,kg\,m^2$

$\Rightarrow \omega = \sqrt{\frac{2K}{I}} = 92.38\ rad/s \qquad \omega = \frac{v}{R} \Rightarrow \underline{v = 13.86\,m/s}$

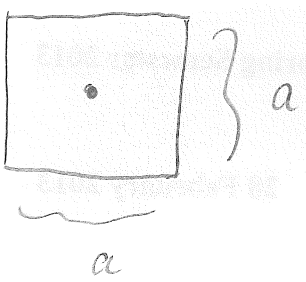
Using energy conservation:

Initially: $E = mgh = 12gh$

Finally: $E = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2 = \frac{1}{2} \cdot 12 \cdot (13.86)^2 + 480 = 12gh$

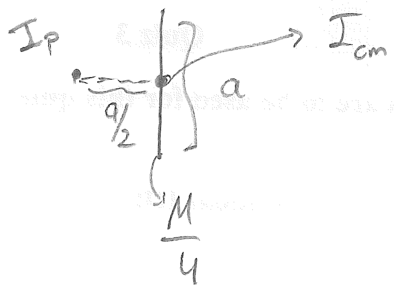
$\Rightarrow \underline{\underline{h = 13.9\,m}}$

9.36



Since total mass is M, each side must be $M/4$.

for each side I_{side}:



using Parallel-axis Theorem:

$$I_p = I_{cm} + \frac{M}{4}\left(\frac{a}{2}\right)^2$$

$$I_{cm} = \frac{1}{12} \cdot \frac{M}{4} \cdot a^2$$

$$I_p = \frac{M}{48}a^2 + \frac{M}{16}a^2 = \frac{M}{12}a^2$$

Total moment of inertia is the sum of all 4 sides:

$$I_{tot} = 4 \cdot I_p = \frac{M}{3}a^2$$