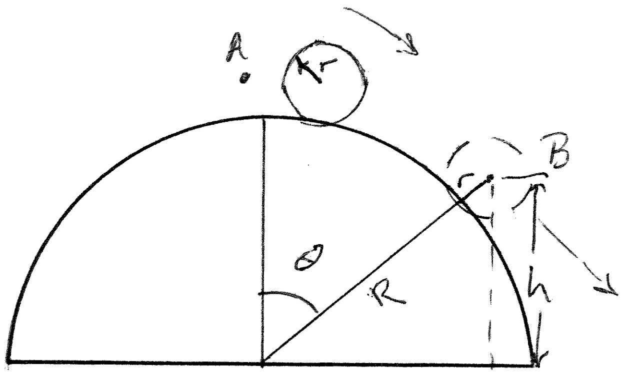
Phys 7a Chiao | MT2 Prob 4 | Soln. by Mat Rogers

$$I_{ring} = mr^2$$

$$h = (R+r)\cos\theta$$




$$E_A = mg(R+r)$$

$$E_B = mg(R+r)\cos\theta + \frac{1}{2}mv_{cm_B}^2 + \frac{1}{2}I\omega_B^2$$

because rolling w.o. slipping $v_{cm_B} = \omega_B r$

by energy conservation

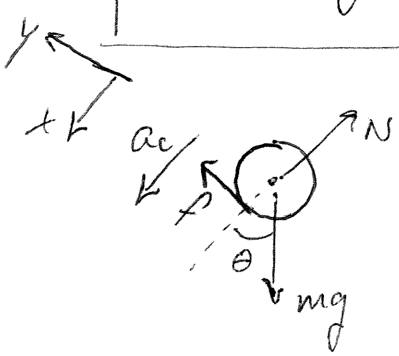
$$E_A = E_B$$

$$mg(R+r) = mg(R+r)\cos\theta + \frac{1}{2}mv_{cm_B}^2 + \frac{1}{2}(mr^2)\left(\frac{v_{cm_B}}{r}\right)^2$$

$$mg(R+r)[1-\cos\theta] = \frac{1}{2}mv_{cm_B}^2 + \frac{1}{2}mv_{cm_B}^2$$

$$\cancel{m}g(R+r)[1-\cos\theta] = \cancel{m}v_{cm_B}^2$$

$$\boxed{v_{cm_B}^2 = g(R+r)[1-\cos\theta]}$$




$$\Sigma F_x : mg\cos\theta - \cancel{N} = ma_c$$

0 when ring flies off

$$\Sigma F_y = f - mg\sin\theta = ma_y$$

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from $\Sigma F_x$: $\cancel{m}g\cos\theta = \cancel{m}\frac{V_{cm_B}^2}{R+r}$

$g(R+r)\cos\theta = V_{cm_B}^2$ ← from Energy Cons.

$g\cancel{(R+r)}\cos\theta = g\cancel{(R+r)}[1-\cos\theta]$

$\cos\theta = 1-\cos\theta$

$2\cos\theta = 1$

$\cos\theta = \frac{1}{2} \Rightarrow \theta = 60^\circ$ or $\frac{\pi}{3}$ rad

$h = (R+r)\cos\theta$

$$\boxed{h = \frac{(R+r)}{2}}$$

Point Allocation:

2 F.B.D.

2 $\Sigma F$ Eqns.

2 $N=0$ when ring flies off & $a_c = \frac{V_{cm}^2}{R+r}$

2 Potential Energy ($U$)

2 Translational KE

2 Rotational KE

2 $I = mr^2$

2 $V_{cm} = \omega r$

2 initial height $= R+r$ height at fall, $h = (R+r)\cos\theta$

2 Soln. for value of $h$

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