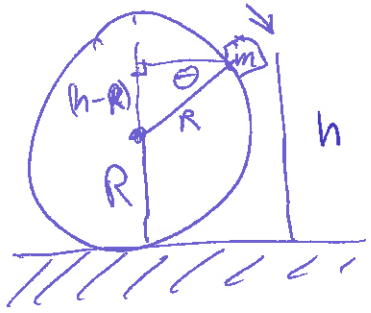
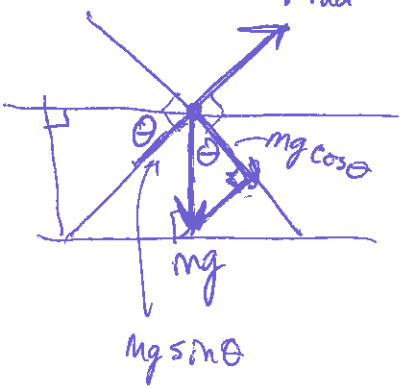
Ch. 7 Globe Problem (HW)



frictionless

Block slides and leaves surface when $\vec{n} = 0$ at h_{crit}, v_{crit}, θ_{crit}

fbd:



$$\sum F_{tan} = mg\cos\theta$$

$$\sum F_{rad} = mg\sin\theta - n = ma \quad (a = \frac{v^2}{R})$$

$$\sin\theta = \frac{h-R}{R}$$

Circular Motion: $F_{rad} = \frac{mv^2}{R}$

At critical pt, $n = 0$ so

$$F_{rad} = \frac{m v_{crit}^2}{R} = mg\left(\frac{h_{crit}-R}{R}\right)$$

$$v_{crit} = \sqrt{g(h_{crit}-R)} \quad \text{Eq. 1}$$

Energy Conservation

Top: $K_T = 0$ $U_T = 2mgR$

Bottom/critical: $K = \frac{1}{2}m v_{crit}^2$ $U = mgh_{crit}$

So $2mgR = \frac{1}{2}m v_{crit}^2 + mg h_{crit}$

$$v_{crit} = \sqrt{2g(2R-h_{crit})} \quad \text{Eq. 2}$$

Combine Eq. 1 & Eq. 2:

$$\sqrt{g(h_{crit}-R)} = \sqrt{2g(2R-h_{crit})}$$

$$3h_{crit} = 5R$$

$$\boxed{h_{crit} = 5R/3}$$

Can also solve for v_{crit}, etc.