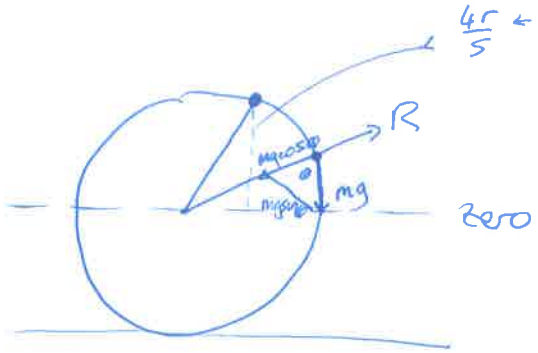
2004

a)



- Forces : $mg\cos\theta - R = \frac{mv^2}{r}$ (1)

- Energy : $mg\frac{4r}{5} + \frac{1}{2}m\theta^2 = mgr\cos\theta + \frac{1}{2}mv^2$

$$\frac{8mgr}{5} = 2mgr\cos\theta + mv^2$$

$$\frac{8mgr}{5} - 2mgr\cos\theta = mv^2 \quad (2)$$

- (2) into (1) :

$$mg\cos\theta - R = \frac{8mg}{5} - 2mg\cos\theta$$

$$3mg\cos\theta - R = \frac{8mg}{5}$$

- leaves sphere : $R = 0$

$$3mg\cos\theta = \frac{8mg}{5}$$

$$\cos\theta = \frac{8}{15}$$

- height $= r\cos\theta = r\frac{8}{15} = \frac{8r}{15}$