11. Resolving radially for motion in circle

$mg\cos\theta - R = \dfrac{mv^2}{r}$

By conservation of energy

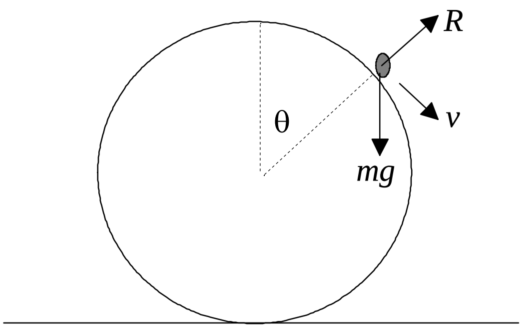
$\dfrac{1}{2}mv^2 = mgr(1-\cos\theta)$

so $mg\cos\theta - R = 2mg(1-\cos\theta)$

$\Rightarrow R = mg(3\cos\theta - 2)$

Particle loses contact when $R = 0$ i.e. $\theta = \arccos\dfrac{2}{3}$

which is the angle of the velocity to the horizontal.



From start particle now falls a distance $2r$ so loss of potential energy is $2mgr$

horizontal component of velocity is $v\cos\theta = \dfrac{2v}{3}$ so if vertical component is V then gain in kinetic energy $= \dfrac{1}{2}m\left(\dfrac{4v^2}{9} + V^2\right)$ and $v^2 = 2gr(1-\cos\theta) = \dfrac{2}{3}gr$

hence, $\dfrac{4v^2}{9} + V^2 = 4gr \Rightarrow V^2 = 4\left(gr - \dfrac{v^2}{9}\right)$ so $V^2 = 4gr\left(1 - \dfrac{4}{81}\right) = \dfrac{308gr}{81}$

so vertical component of momentum at floor is $\dfrac{308mgr}{81}$
