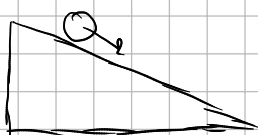


Sources:

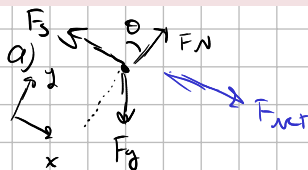
<https://courses.lumenlearning.com/suny-osuniversityphysics/chapter/11-1-rolling-motion/>
3000 solved problems in physics section 6.1

Rolling Down an Inclined Plane

A solid cylinder rolls down an inclined plane without slipping, starting from rest. It has mass m and radius r . (a) What is its acceleration? (b) What condition must the coefficient of static friction μ_s satisfy so the cylinder does not slip?



$$v_0 = 0, \quad a = ?$$



$$b) \mu_s \geq \tan \theta$$

$$\sum F_x = F_g \sin \theta - \mu_s N = ma$$

$$\sum F_y = F_N - F_g \cos \theta = 0$$

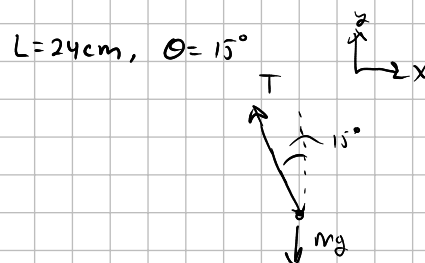
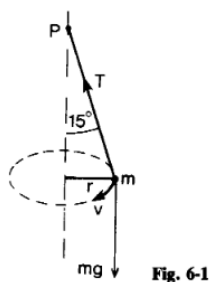
$$F_N = F_g \cos \theta$$

$$F_g \sin \theta - \mu_s mg \cos \theta = ma$$

$$g \sin \theta - \mu_s g \cos \theta = a$$

$$a = g(\sin \theta - \mu_s \cos \theta)$$

- 6.2 A small ball is fastened to a string 24 cm long and suspended from a fixed point P to make a conical pendulum, as shown in Fig. 6-1. The ball describes a horizontal circle about a center vertically under point P , and the string makes an angle of 15° with the vertical. Find the speed of the ball.



$$\text{net force} = F_c = m \frac{v^2}{r}$$

$$mg = T \cos \theta \quad m \frac{v^2}{r} = T \sin \theta$$

$$T = \frac{mg}{\cos \theta}$$

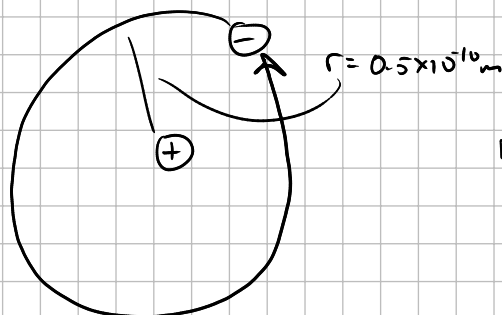
$$m \frac{v^2}{r} = \frac{mg}{\cos \theta} \sin \theta \Rightarrow \frac{v^2}{r} = g \tan \theta$$

$$v = \sqrt{g r \tan \theta}$$

$$L \sin \theta = r$$

$$v = \sqrt{g L \sin \theta \tan \theta} = \sqrt{(9.81 \frac{m}{s^2})(24 \times 10^{-2} m) \sin(15^\circ) \tan(15^\circ)} = 0.40 \frac{m}{s} = 40.4 \frac{cm}{s}$$

- 6.3 In the Bohr model of the hydrogen atom an electron is pictured rotating in a circle (with a radius of $0.5 \times 10^{-10} m$) about the positive nucleus of the atom. The centripetal force is furnished by the electric attraction of the positive nucleus for the negative electron. How large is this force if the electron is moving with a speed of $2.3 \times 10^6 m/s$? (The mass of an electron is $9 \times 10^{-31} kg$.)



$$v_e = 2.3 \times 10^6 \frac{m}{s}$$

$$m_e = 9 \times 10^{-31} kg$$

$$F_c = m \frac{v^2}{r} = (9 \times 10^{-31} kg) \frac{(2.3 \times 10^6 \frac{m}{s})^2}{0.5 \times 10^{-10} m} = 9.5 \times 10^{-8} N$$