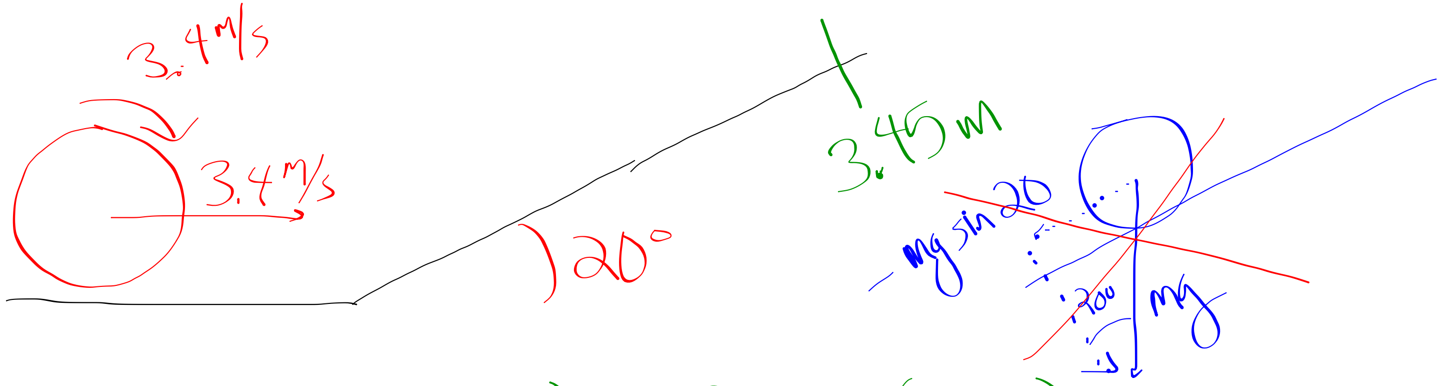
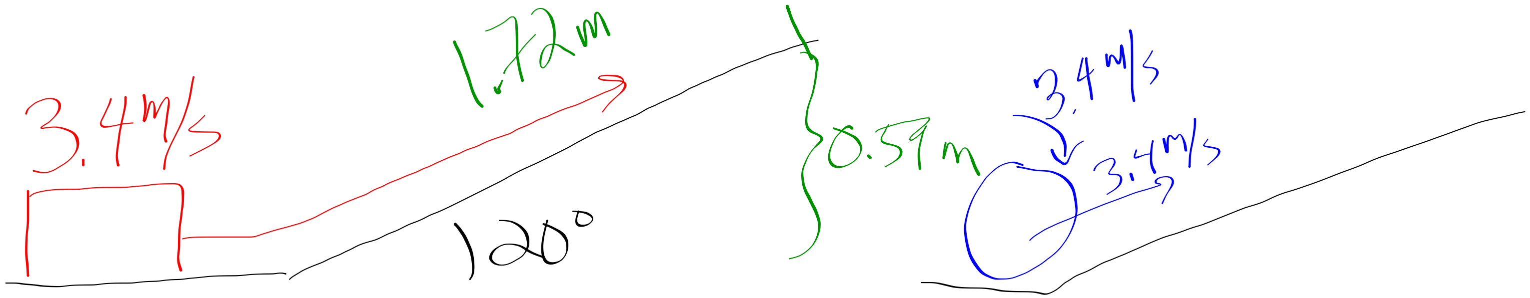
44. A hollow cylinder (hoop) is rolling on a horizontal surface at a speed of 3.4 m/s when it reaches a 20° incline.
    a) How far up the surface of the incline will it go?
    b) How long will it be on the incline before it arrives back at the bottom?



$x_0 = 0$
$x = 3.45$
$v_0 = 3.4$
$v = 0$
$a = \cancel{-3.35\ m/s^2}$
$t = \cancel{1.01\ s \times 2 = 2.02\ s}$

$v^2 = v_0^2 + 2a(x - x_0)$
$0 = 3.4^2 + 2a(3.45)$
$a = -1.68\ m/s$

$t = 2.02\ s \times 2 = \boxed{4.04\ s}$



$$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$

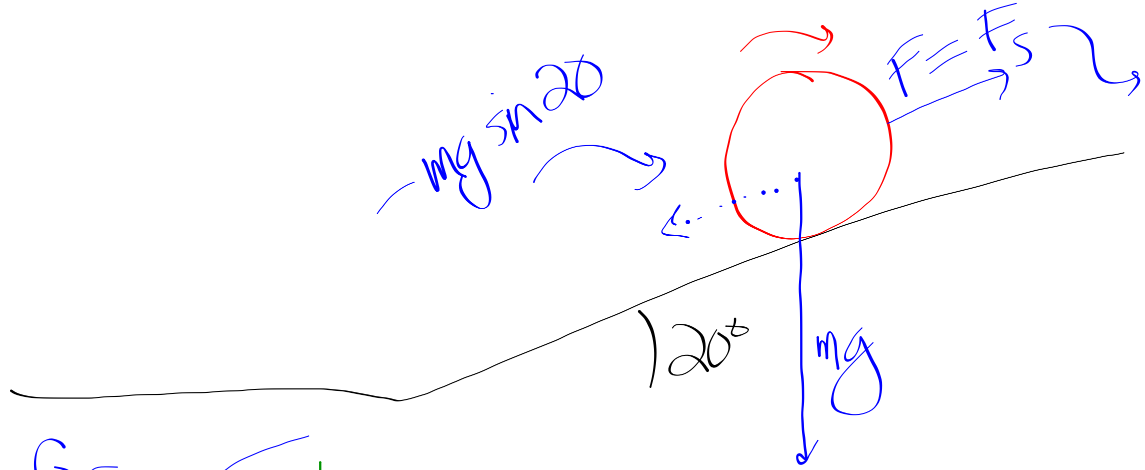
2x K.E.

$$h = \frac{\frac{1}{2}v^2}{g} = 0.59\,m$$

$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh$$

$$\frac{1}{2}mv^2 + \frac{1}{2}(m\cancel{r^2})\frac{v^2}{\cancel{r^2}} = mgh$$

$$mv^2 = mgh$$

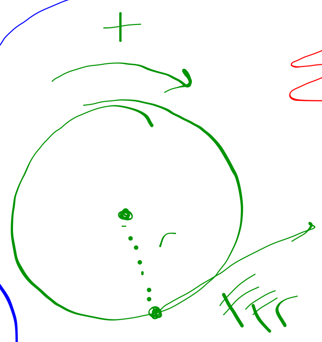


between the ramp and the point on the hoop in contact with the ramp?

solve for F_{Fr} by using angular Big 4

$\theta_0 = 0$

$\theta = ?$



$\Sigma\tau = I\alpha$

$\underbrace{\tau = -F_{Fr} \cdot r}$

this torque is why the hoop's spinning slows down . . .

$\underbrace{\dfrac{mg\sin 20 =}{-3.35\ m/s^2} \qquad \dfrac{F_{Fr}}{\frac{1}{2}mg\sin 20 = 1.68\ m/s^2}}$

$a_{net} = -1.68\ m/s^2$

8. Upon completion of a new, super-large space telescope, a planetary system is observed on another star. The innermost planet is seen to have a period of 115 days and orbits at a distance of $\boxed{8 \times 10^9 \text{ m}}$. What is the mass of the star? [3.07×10^{27} kg]

$$115 \text{ days} \cdot \frac{24 \text{ h}}{\text{day}} \cdot \frac{3600 \text{ s}}{\text{h}} = 9,936,000 \text{ s}$$

$$F_g = F_c$$

$$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

$$v = \frac{2\pi r}{T} = \frac{2\pi(8e9)}{9,936,000} = 5056.4 \text{ m/s}$$

$$\frac{GM}{r} = v^2 \;;\; M = \frac{v^2 \cdot r}{G} = \frac{(5056)^2(8e9)}{6.67e{-11}}$$

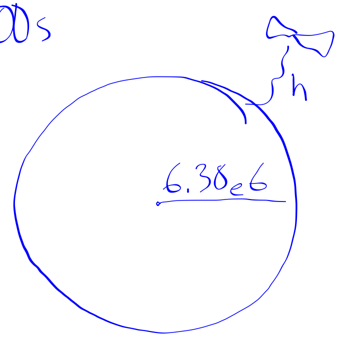
$$M = 3.1 \times 10^{27} \text{ kg}$$

9. If a satellite circles the Earth in 2 hours, what is the altitude of the satellite's orbit (how high is it above the Earth)? The mass of the Earth is 5.98 x 10^{24} kg, the radius of the Earth is 6.38 x 10^{6} meters. [1.68 x 10^{6} m]

→ 7200s

$$\frac{GM\cancel{m}}{r^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

$$v = \frac{2\pi r}{T}$$



$$v = \frac{2\pi(6.3e6 + h)}{7200}$$

$$\left(\frac{2\pi(6.3e6+h)}{7200}\right)^2 = \frac{(6.67e^{-11})(5.98e24)}{(6.38e6+h)}$$

$$\frac{(2\pi)^2(6.38e6+h)^3}{7200^2} = (6.67e^{-11})(5.98e24)$$

$$(6.38e6+h)^3 = 5.24e20$$

$$6.38e6 + h = 8063512$$

$$\boxed{h = 1683512\ m}$$

10. An astronaut, standing on a new planet, finds that a 35-kg dog weighs 1400 N. She further notes that the period of a satellite just skimming the surface of the planet (having an orbit equal to the radius of the planet) is 150 minutes. What is the radius of the planet? [8.21 x 10^7 m]

$$W = m \cdot a_g$$

$$1400 = 35 \cdot a_g$$

$$a_g = 40\ m/s^2$$

$$v = \frac{2\pi r}{T} = \frac{2\pi r}{9000}$$

$$\overset{F_g}{\frac{GM\cancel{m}}{r^{\cancel{2}}}} = \overset{F_c}{\frac{\cancel{m}v^2}{\cancel{r}}}$$

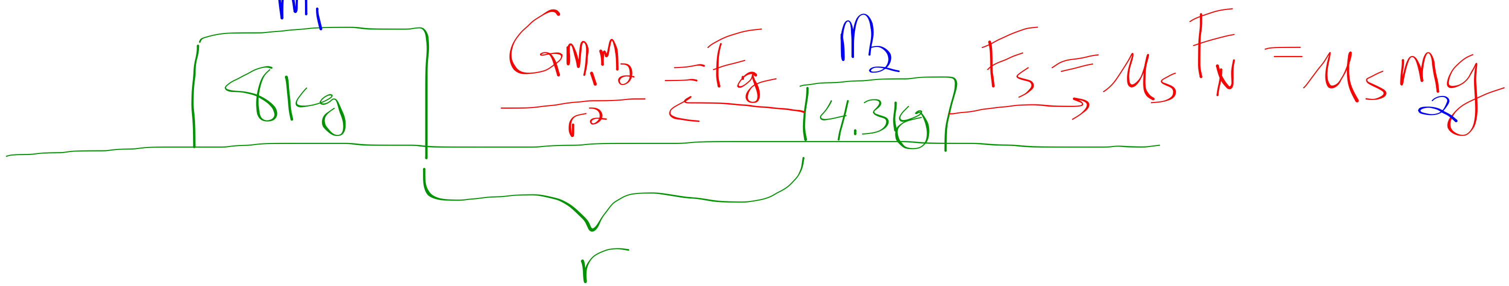
$$\underbrace{\frac{GM}{r^2}}_{a_g} = \underbrace{\frac{v^2}{r}}_{a_c}$$

$$40\ m/s^2 = \frac{\left(\frac{2\pi r}{9000}\right)^2}{r}$$

$$\frac{40 \cdot 9000^2}{(2\pi)^2} = r = \boxed{82{,}153{,}434\ m}$$

11. Two masses are on a frictional, horizontal surface. If the 8-kg mass is brought close to a 4.3-kg mass on a surface with a coefficient of friction of .2, at what distance will the 4.3-kg mass begin to slide toward the 8-kg mass? [1.65×10^{-5} m]

$\mu_s = 0.2$



$$\frac{Gm_1\cancel{m_2}}{r^2} = \mu_s \cancel{m_2} g$$

$$r = \sqrt{\frac{Gm_1}{\mu_s g}} = \sqrt{\frac{(6.67e{-11})(8)}{(0.2)(9.8)}} = \boxed{1.65\times10^{-5}\ m}$$

19. A car speeds over a hill at 18 m/sec. If the hill has a radius of 130 meters, what is the apparent weight of a 70-kg passenger at the top of the hill? [511.5 N]

$$\frac{v^2}{r} = a_c$$

$$2.49 = \frac{(18)^2}{130}$$

$$2.49 \cdot 70 = F_c$$

174.5 N

$F_g = mg = 686N$

$F_c = 174.5N$

511.5N

34. A 2-kg toad sits on the edge of a 3-kg lazy susan (a disk), which has a radius of 0.34 m. If the system rotates initially at 4 rad/sec and the toad hops to a point 0.10 m from the center, what is the new angular velocity? [8.37 rad/sec]

$$I_o w_o = I_f w_f$$

$$I = m_d r_d^2 + m_t r_t^2$$

$$I_o = \frac{1}{2}(3)(0.34^2) + (2)(0.34^2) = 0.4 \ kg \cdot m^2$$

$$I_f = \frac{1}{2}(3)(0.34^2) + (2)(0.1^2) = 0.19 \ kg \cdot m^2$$

$$(0.4)(4) = 0.19 w_f$$

$$w_f = 8.42 \ rad/s$$