1. If T is the period of an orbit, then the linear speed v of the object is $v = \frac{2\pi R}{T}$, where R is the distance.
Now apply Newton's 2nd law and gravitational law

the centripetal force = the gravitational force

$$\frac{mv^2}{R} = \frac{m(2\pi R/T)^2}{R} = \frac{4\pi^2 MR}{T^2}$$

$\therefore$ for the planet.

$$\frac{4\pi^2 M_p R_p}{T_p^2} = \frac{G M_s M_p}{R_p^2} \quad -(1)$$

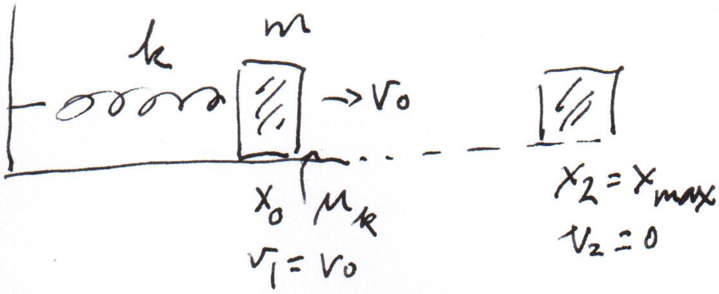
for the moon

$$\frac{4\pi^2 m R_m}{T_m^2} = \frac{G M_p m}{R_m^2} \quad -(2)$$

m = mass of the moon

$$\therefore \quad \frac{M_s}{M_p} = \frac{4\pi^2 R_p^3 / G T_p^2}{4\pi^2 R_m^3 / G T_m^2} = \left(\frac{R_p}{R_m}\right)^3 \left(\frac{T_m}{T_p}\right)^2$$

2 (a)



(b) The moment after the block is struck. The total energy of this system is $\frac{1}{2}mv_0^2$

when the block is arrested @ the position x_2 it is also the maximum distance the block can travel, $x_2 = x_{max}$

$v_2 = 0$

So when the block is at $x_2 = x_{max}$. it stop $v_2 = 0$

the system will have total energy $\frac{1}{2}kx_{max}^2 = \frac{1}{2}mv_0^2 \underbrace{-\mu_k mg(x_m - x_0)}$

this part is the negative work due to the frictional force

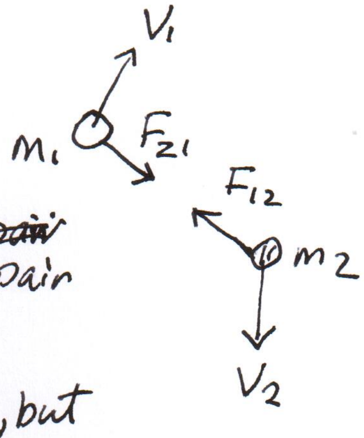
Solve this quadratic equation for the x_m

$$x_m = \pm\sqrt{\left(\frac{\mu_k mg}{k}\right)^2 + \frac{mv_0^2}{k}} - \frac{\mu_k mg}{k}$$

(rejecting the negative root)

3. Moment conservation

As shown in the figure to the right,



During the collision. a ~~pair~~ pair of action-Reaction forces are formed. they are same, but ~~to~~ opposite in directon

$$\therefore \vec{F}_{12} + \vec{F}_{21} = 0 \qquad m_1 a_1 + m_2 a_2 = 0$$

$$\rightarrow m_1 \frac{dV_1}{dt} + m_2 \frac{dV_2}{dt} = 0$$

$$\rightarrow \frac{d(m_1 V_1)}{dt} + \frac{d(m_2 V_2)}{dt} = 0$$

$$\rightarrow \frac{d}{dt}(m_1 V_1 + m_2 V_2) = 0 \Rightarrow m_1 V_1 + m_2 V_2 = \text{constant}$$

$$\rightarrow P_1 + P_2 = \text{Constant}$$

$\rightarrow$ Therefore momentum is conserved after the collection

4. A garden hose is held as shown in Figure P9.32. The hose is originally full of motionless water. What additional force is necessary to hold the nozzle stationary after the water flow is turned on if the discharge rate is 0.600 kg/s with a speed of 25.0 m/s?

<u>Solution:</u>

The force exerted on the water by the hose is

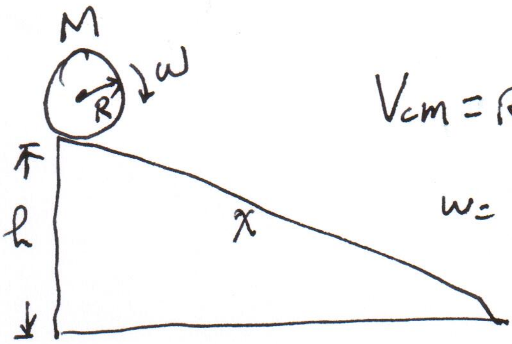
Figure P9.32

$$F = \frac{\Delta p_{\text{water}}}{\Delta t} = \frac{mv_f - mv_i}{\Delta t} = \frac{(0.600\ \text{kg})(25.0\ \text{m/s}) - 0}{1.00\ \text{s}}$$

$$= \boxed{15.0\ \text{N}}$$

According to Newton's third law, the water exerts a force of equal magnitude back on the hose. Thus, the gardener must apply a 15.0-N force (in the direction of the velocity of the exiting water stream) to hold the hose stationary.

5 (a)



$V_{cm} = R\omega$. ω = rotation angular velocity

$\omega = \frac{V_{cm}}{R}$

(b) Total Kinetic energy = Kinetic energy + rotation kinetic energy

$$K = \frac{1}{2} I_{cm}\omega^2 + \frac{1}{2} m V_{cm}^2$$

$$= \frac{1}{2} I_{cm}\left(\frac{V_{cm}}{R}\right)^2 + \frac{1}{2} M V_{cm}^2$$

$$= \frac{1}{2}\left(\frac{I_{cm}}{R} + M\right) V_{cm}^2 = K_f$$

(c) During the rolling, Total energy is conserved

$$K_f + U_f = K_i + U_i$$

$$\frac{1}{2}\left(\frac{I_{cm}}{R} + M\right) V_{cm}^2 + 0 = 0 + Mgh$$

$$\therefore V_{cm} = \left(\frac{2gh}{1 + \frac{I_{cm}}{MR^2}}\right)^{\frac{1}{2}}$$