A1) Since the Earth and the comet both orbit the Sun their orbits are proportional

A1)

$$\frac{T_a^2}{T_b^2} = \frac{r_a^3}{r_b^3}$$

$$r_a = \frac{(.9 + 325)}{2}$$

$$r_a = 162.95\ AU$$

$$\frac{T_a^2}{(1)^2} = \frac{(162.95)^3}{1^3}$$

$$\boxed{T_a = 2080 \text{ years}}$$

A2) The accel due to gravity is based on the physical properties of the planet

A2)

$t = .12s$ $\quad d = .50m$ $\quad 2M_E$

$$d = V_i t + \tfrac{1}{2}at^2$$

$$.5 = \tfrac{1}{2}a(.12)^2 \qquad a = 69.444\ m/s^2$$

$$F = mg = G\frac{m_1 M_p}{r_p^2}$$

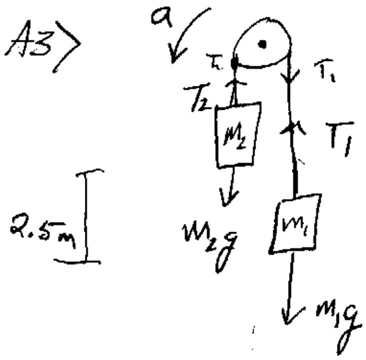
$$r_p^2 = G\frac{M_p}{g}$$

$$r_p^2 = \frac{(6.67\times10^{-11})(2(5.97\times10^{24}))}{69.444}$$

$$\boxed{r_p = 3.39\times10^6\ m}$$

A3> The unbalanced weights cause the system to accelerate

A3>



$$a = \alpha r$$

$$\Sigma \tau = F\ell = I\alpha$$

$$(-T_1 + T_2) r = I\alpha = I\left(\frac{a}{r}\right)$$

$$m_1 = 22.5\ kg \qquad r = .3m \qquad m_2 g - T_2 = m_2 a$$

$$m_2 = 33.2\ kg$$

$$T_2 = m_2 g - m_2 a \qquad -m_1 g + T_1 = -m_1 a$$

$$T_1 = m_1 g - m_1 a \qquad I = \tfrac{1}{2} m r^2$$

$$(-T_1 + T_2) r^2 = I a$$

$$-m_1 g + m_1 a + m_2 g - m_2 a = I \frac{a}{r^2}$$

$$-m_1 g + m_2 g = I\frac{a}{r^2} - (m_1 a - m_2 a)$$

$$-m_1 g + m_2 g = a\left[I/r^2 - m_1 + m_2\right]$$

$$-m_1 g + m_2 g = a\left(\frac{\tfrac{1}{2} m \cancel{r^2}}{\cancel{r^2}} - m_1 + m_2\right]$$

$$\frac{-(22.5)(9.8) + (33.2)(9.8)}{\tfrac{1}{2}(8.8) - (22.5) + 33.2} = a$$

$$a = 6.94\ m/s^2$$

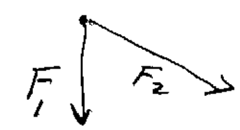
$$V_f^2 = \cancelto{0}{V_i^2} + 2ad$$

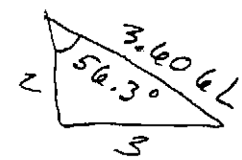
$$V_f^2 = 2(6.94)(2.5)$$

$$\boxed{V_f = 5.89 m/s}$$

A4) The balls are all attracted to each other due to gravitational attraction of their masses. The forces add vectorally.

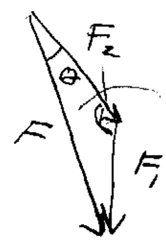
A4)





$$F = G\frac{m_1 m_2}{r^2}$$

$$F_1 = G\frac{m^2}{(2L)^2} \qquad F_2 = G\frac{m^2}{(3.606L)^2}$$



$180 - 56.3 = 123.69$

$$F^2 = F_2^2 + F_1^2 - 2F_2F_1\cos(123.7)$$

$$F^2 = \left[G\frac{m^2}{4L^2}\right]^2 + \left[G\frac{m^2}{(3.61L)^2}\right]^2 - 2\left[G\frac{m^2}{4L^2}\right]\left[G\frac{m^2}{(3.61L)^2}\right]\cos(123.7)$$

$$F^2 = G^2\frac{m^4}{L^4}\left[\left[\frac{1}{4}\right]^2 + \left[\frac{1}{3.61^2}\right]^2 - 2\left[\frac{1}{4}\right]\left[\frac{1}{3.61^2}\right]\cos(123.7)\right]$$

$$F^2 = G^2\frac{m^4}{L^4}\left(8.97\times10^{-2}\right)$$

$$F = \left(6.67\times10^{-11}\right)\frac{m^2}{L^2}\sqrt{8.97\times10^{-2}}$$

$$\boxed{F = 2.00\times10^{-11}\ m^2/L^2 \text{ @ } 12.3^\circ \text{ from } F_1}$$

$$\frac{\sin\theta}{F_1} = \frac{\sin(123.69)}{F}$$

$$\sin\theta = \frac{\sin(123.69)\ G\frac{m^2}{4L^2}}{G\frac{m^2}{L^2}\sqrt{8.97\times10^{-2}}}$$

$$\theta = 43.99$$

A5> All masses are gravitational attracted to each other.

A5>

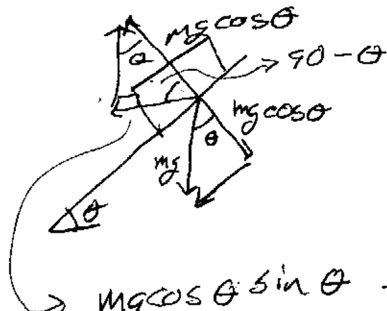
$$F = G\frac{m_1 m_2}{r^2}$$

$$F = (6.67\times10^{-11})\ \frac{(20)(77)}{(.78)^2}$$

$$\boxed{F = 5.91\times10^{-7}\,N}$$

A6> Part of the normal force provides the centripetal force.

A6>



$$mg\cos\theta\sin\theta = F_c = \frac{mv^2}{r}$$

$$g(\tfrac{1}{2})\sin(2\theta) = \frac{v^2}{r}$$

$$\sin 2\theta = \frac{2v^2}{gr} = \frac{2(20.1)^2}{(9.8)\,r}$$

$$\boxed{\theta = \frac{1}{2}\sin\left[\frac{82.4}{r}\right]}$$

A7> The two objects have different mass arrangements but must have the same moment of inertia.

A7>

$$I_H = I_D$$

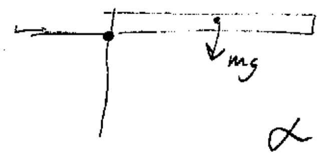
$$m r_H^2 = \tfrac{1}{2} m_1 r_D^2$$

$$r_H^2 = \tfrac{1}{2} r_D^2$$

$$(.3)^2 = \tfrac{1}{2} r_D^2$$

$$\boxed{r_D = .424\,m}$$

A8) the weight is going to act through the center of mass of the meter stick. This creates torque.

A8) 

$a = \alpha r$

$\alpha = \frac{a}{r_{cm}} = \frac{a_T}{r_{end}}$

$g/(.5) = a_T/(1)$

$\boxed{a_T = 2g}$

A9) Since the moon has mass and it is arranged roughly as a sphere it has a moment of inertia

A9) $I = 2/5\, mR^2$

$I = 2/5\,(7.35\times10^{22})(1.74\times10^{6})^2$

$\boxed{I = 8.90\times10^{34}\ \mathrm{kg\,m^2}}$

A10)

A $.646^r$ $.206\pi^r$

B 1.59^r $.506\pi^r$

C 4.94^r $1.57\pi^r$

D 3.12^r $.994\pi^r$

E 1.34^r $.428\pi^r$

B1) the total mom of Int is a sum of the individual mom Inert

B1)

$$I_T = I_S + I_{TD} + I_{BD}$$

$$I_T = \tfrac{2}{5}mr^2 + \tfrac{1}{2}mr^2 + \tfrac{1}{2}mr^2$$

$$I_T = \tfrac{2}{5}(.15)(.05)^2 + \tfrac{1}{2}(.07)(.05)^2 + \tfrac{1}{2}(.21)(.15)^2$$

$$\boxed{I_T = .065\ kgm^2}$$

B2) Torque is produced by a force applied through a lever arm and maximum torque is when the force and arm are ⊥

B2)

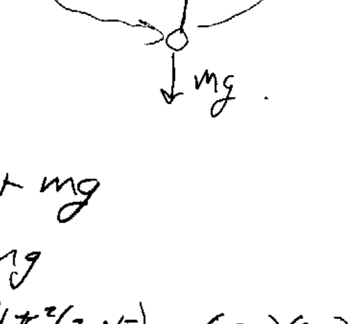
$$\tau = FL$$

$$\tau = (125)(.38)$$

$$\boxed{\tau = 47.5\ m\cdot N}$$

B3) The centripital force is provided by the tension and the weight at the top. At the bottom tension provides cent. force and weight.

B3)



$m = 1.28\ kg$

$r = 2.05\ m$

$T = 13.2\ ms$

$$F_c = m\frac{4\pi^2 r}{T^2}$$

Top

$$F_c = T_T + mg$$

$$T_T = F_c - mg$$

$$T_T = \frac{(1.28)4\pi^2(2.05)}{(13.2\times10^{-3})^2} - (128)(9.8)$$

$$T_T = 5.95\times10^5\ N$$

Bottom

$$T = F_c + mg$$

$$T_B = \frac{(1.28)\,4\pi^2(2.05)}{(13.2\times10^{-3})^2} + (1.28)(9.8)$$

$$T_B = 5.95\times10^5\,N$$

$$T_T = 594520\,N$$

$$T_B = 594545\,N$$

B4) The planet and the Earth orbit the same sun.

B4)

$$\frac{T_a^2}{T_b^2} = \frac{r_a^3}{r_b^3}$$

$$\frac{(29.5)^2}{1^2} = \frac{r_a^3}{1^3} \qquad \boxed{r_a = 9.55\ AU}$$

B5) a net torque will cause an angular acceleration of the body.

B5)

$$300\text{ rpm} \Rightarrow \left[\frac{2\pi^r}{1\,r}\right]\left[\frac{1\ \text{min}}{60\ s}\right] = 10\pi\ \text{rad/s}$$

$$\omega_f = \omega_i + \alpha t$$

$$0 = (10\pi) + \alpha(3.2)$$

$$-10\pi = 3.2\alpha$$

$$\alpha = -\frac{10\pi}{3.2}$$

$$\tau = I\alpha$$

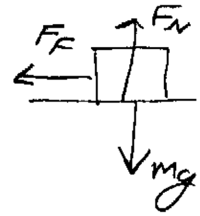
$$FL = mr^2\alpha$$

$$F(.25) = (.56)(.75)^2\left(\frac{10\pi}{3.2}\right)$$

$$\boxed{F = 4.12\,N}$$

B6> The centripetal force must be provided by friction

B6>



$$F_c = F_F$$

$$m_c \frac{v^2}{r} = \mu F_N = \mu mg$$

$$\frac{(27)^2}{r} = (.94)(9.8)$$

$$\boxed{r = 79.1\ m}$$

B7> The centrifugal force must balance the weight of the water. The centrifugal force will equal the centripetal force.

B7>

$$F_c = mg$$

$$\frac{mv^2}{r} = mg$$

$$\frac{v^2}{(.2 + .65)} = 9.8$$

$$\boxed{V = 2.89\ m/s}$$

B8>

In orbit

$$F_c = F_G$$

$$m_p \frac{4\pi^2 r}{T^2} = G \frac{m_p m_s}{r^2}$$

$$\frac{r^3}{T^2} = \frac{m_s}{4\pi^2}$$

This is a constant so same for all bodies orbiting this body.

B9) the centrifugal force provided by the circular motion and makes simulated gravity.	B9)

$$F_c = F_g$$

$$\frac{m 4\pi^2 r}{T^2} = mg$$

$$\frac{4\pi^2 r}{g} = T^2$$

$$\frac{4\pi^2(149.6\times10^9)}{9.8} = T^2$$

$$\boxed{\begin{array}{l} T = 7.76\times10^5\,s \\ 8.98 \text{ days} \end{array}}$$