1. The mass of Summer’s spacecraft’s is $M$. When orbiting the small planet of Glip Glop, the spacecraft’s period is $T$, and its mean distance from the center of Glip Glop is $D$.
   a. Assuming the orbit of the spacecraft is circular and Glip Glop to be a uniform sphere, determine the mass of Glip Glop in terms of $M$, $T$, and $D$.

   b. If $M=10,000$ kg, $T=120$ minutes and $D=1.8 \times 10^6$ m, what is the mass of Glip Glop with correct units and 2 significant figures? Remember $G = 6.67 \times 10^{-11}$ N-m$^2$/kg$^2$.

   c. Given that the mean radius of Glip Glop is $R=1700$ km, what is the value of the gravitational acceleration at the surface of Glip Glop?

   d. Only the lander portion of Summer’s spacecraft, with mass $m=4.7 \times 10^3$ kg, lands on Glip Glop. How much does the lander portion weigh?
2. Consider a uniform rod of mass $M$ and length $L$. Attached at the left end is a small mass $m_L$ and attached at the right end is another small mass $m_R$. The whole system is hung from the ceiling by one rope such that the rod is horizontal.

a. Sketch this system.

b. If the rod is in equilibrium what is the total torque acting on the rod? What is the total force acting on the rod?

c. Use this information to find an expression for how far from the right end of the rod the rope must be attached in order for it to be in equilibrium. Your answer should be in terms of $m_L, m_R, M, L,$ and $g$.

d. If $L = 1.0 \text{ m, } M = 3.0 \text{ kg, } m_R = 1.5 \text{ kg, and } m_L = 1.0 \text{ kg}$ how far from the right end of the rod must the rope be attached? $g=9.8 \text{ m/s}^2$. Correct answers have correct units and 2 significant figures.
3. Two discs with moments of inertia \( I \) rotate freely about the same vertical axis without friction. Initially one disc has angular speed \( \omega_1 \) and the other \( \omega_2 \). The discs come into contact and due to friction rotate together at the same angular velocity \( \omega_f \).

a. What is the initial angular momentum?

b. What is the final angular momentum?

c. What is the final angular speed in terms of \( \omega_1 \) and \( \omega_2 \)?

d. What is the initial kinetic energy of the system of both discs?

e. Write an expression for the ratio of the final kinetic energy to the initial kinetic energy. Your answer should be in terms of \( \omega_1, \omega_2, \) and \( I \).

f. Find the numerical value of this ratio of kinetic energies in the case where \( I = 2 \text{ kg m}^2 \), \( \omega_1 = 6 \text{ radians/s} \), and \( \omega_2 = 3 \text{ radians/s} \).
4. A uniform rod of mass $M$ and length $L$ sticks out from a wall as shown in the diagram below. It is supported by a hinge at the wall and a cable at the other end. A small mass $m$ sits on the rod three-quarters of the way out to the edge of the rod.

a. Write out the sum of the forces acting on the rod in the $x$ and $y$ direction and the sum of the torques acting on the rod about the hinged end.

b. Use these to write an expression for $F_y$, the force exerted on the rod by the hinge in the $y$-direction.

c. Write an expression for $F_x$, the force exerted on the rod by the hinge in the $x$-direction.

d. What is the magnitude of the total force exerted on the rod by the hinge in terms of $F_x$ and $F_y$ in general?

e. For the case where $M = 4.0$ kg and $m = 1.0$ kg, find the magnitude of the total force.

$$G = 6.7 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2 \quad F_g = \frac{(Gm_1 m_2)}{(r_{12}^2)} \quad U_g = -\frac{(Gm_1 m_2)}{r}$$

$$L = r \quad \text{xp} = |r| |p| \sin \theta \quad F = ma = (mv^2)/r \quad p = mv \quad \text{KE} = 1/2 \text{ mv}^2$$

$$2\pi f = 2\pi/T = \omega = v/r$$