PHY6938 Mechanics Fall 99
January 11, 2000

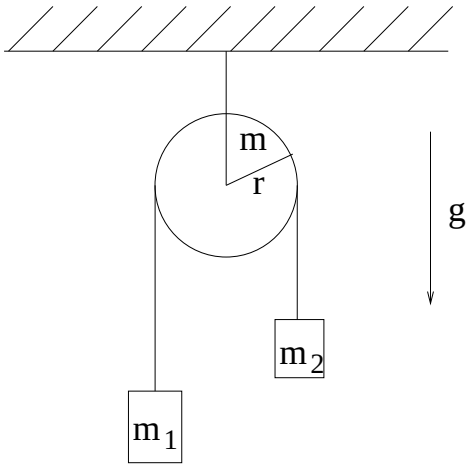
1. The system (Atwood's machine) shown in the figure consists of two masses, M_1 and M_2, attached to the ends of a string of length l which hangs over a pulley. The pulley is a uniform disk of radius r and mass m. Assume the string is massless and does not slip on the pulley.

a) What is the moment of inertia of the pulley about its axis? (Perform a calculation to determine I; don't just write down a remembered answer).

b) Obtain the acceleration of the masses.

c) Find the tension in the string on both sides of the pulley.

d) Write down an expression for the total energy of the system.



2. Use the following data to estimate the ratio of the average density of the Earth and the Sun:

θ = the angular diameter of the Sun viewed from the Earth $\simeq 0.5^o$
l = the length of each degree of latitude on the surface of the Earth $\simeq 110$ km
$T = 1$ year $\simeq 3 \times 10^7$ s
$g = 10$ m/s^2.

3. A cylindrical block of wood of density ρ_w, radius R, and height h is partially immersed in a liquid of density ρ_l and then released, as shown in the figure.

a) What is the condition for the block to keep afloat?

b) What is the equilibrium height of the block above the water level $z_{\rm eq}$?

c) If the block was initially slightly raised, so that $z(t=0) > z_{\rm eq}$, and then released, calculate $z(t)$ assuming no friction.

d) Now assume that the liquid is very viscous, and that the viscous force is proportional to the velovity, as given by $\mathbf{F}_v = -b\mathbf{v}$. How is the motion of the block modified?

e) What is the condition for the oscillatory motion to be over-damped?