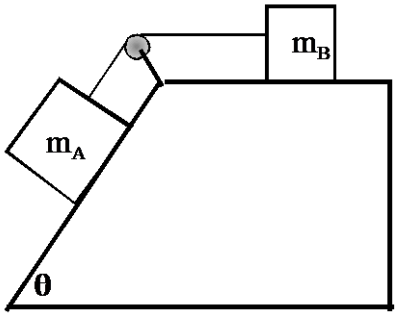
Physics 1145 Homework #8: More force problems. Gravity and orbits.

Remember to draw fully labeled free-body diagrams for every object in problem 1-4.

1. Two blocks are connected by a massless string that runs over a massless and frictionless pulley. Block A of mass m_A is on a **rough inclined plane** that makes angle θ with the horizontal and has a coefficient of kinetic friction μ with the block. Block B of mass m_B is on a **frictionless horizontal** surface. The blocks are released from rest, and block A moves down the ramp.

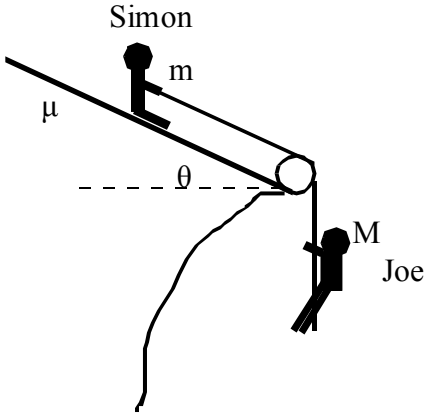


a) Derive an expression for the magnitude of the normal force on block A.

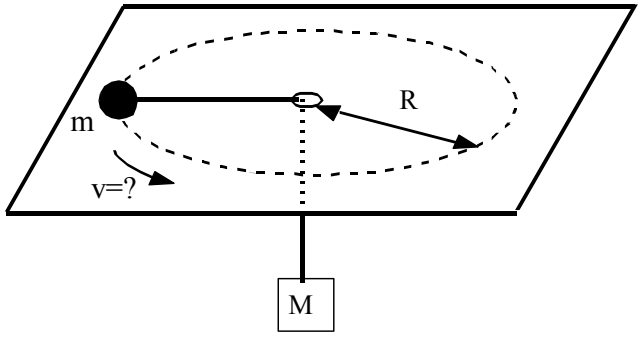
b) Find an expression for the magnitude of the force of kinetic friction on block A.

c) Set up Newton's 2nd Law for each block and derive an expression for the acceleration in terms m_A, m_B, θ and g.

2. Two climbers are on a mountain. Simon, of mass *m*, is sitting on a snow covered slope that makes an angle θ with the horizontal. The coefficient of **static** friction between his body and the snow is μ. He is tied into one end of a massless rope that runs over a frictionless pulley. Joe, of mass *M*, is at the other end of the rope. He has fallen and is hanging motionless below an overhang. Derive an expression for the maximum value of Joe's mass *M* so that Simon is not pulled down the slope.



3. A flat disk of mass *m* is moving on a frictionless, horizontal table in a circle with constant radius *R*. It moves with constant speed. It is held in its path by a massless cord that is connected to a dangling block of mass *M*, through a hole in the center. The block is at rest.



a) Derive an expression for the tension in the cord.

b) Derive an expression for the speed *v* of the disk in terms of *M*, *m*, *R*, and *g*.

II. Gravity and orbits

4. Uranus has a mass of 8.68×10^{25} kg and a radius of 2.33×10^{7}m.
Find a symbolic answer and calculate a numerical value for the free-fall acceleration on the surface of Uranus.

5. Jupiter's moon Io has a mass of m= 8.9×10^{22}kg. It is orbiting Jupiter at a distance 4.22×10^{8}m and has an orbital period of 1.77 Earth days.
Find a symbolic answer and calculate a numerical value for the mass of Jupiter.

6. The Moon has a radius of 1.74×10^{6}m. It is orbiting the Earth at a distance of 3.84×10^{8}m, taking 27.3 days for a complete revolution. The free-fall acceleration on Moon is 1.62 m/s^2.
From the information given, find the mass of the Moon and the mass of Earth. Derive symbolic answers and calculate numerical values.