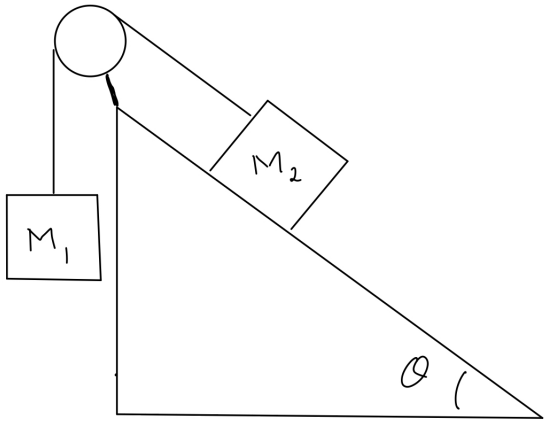
Problem 1

Consider the set of blocks shown below. One block, of mass M_2, sits on a ramp that makes an angle of θ with the horizontal. The other block, of mass M_1, is attached to the first block by a rope over a pulley, and hangs from the rope. You may assume the ramp is frictionless. You observe that the blocks are at rest. Use the following symbols for the quantities in this problem:

- $\vec{w}_1$: weight of the block of mass M_1
- $\vec{w}_2$: weight of the block of mass M_2
- $\vec{n}$: normal force
- $\vec{T}_1$: tension acting on the block of mass M_1
- $\vec{T}_2$: tension acting on the block of mass M_2



(a): 10 points

Draw a free-body diagram for the block of mass M_1. Be sure to label your force vectors clearly. The length of the force vectors is not important; the direction is what matters.

Problem 1 continued on next page...

(b): 10 points

Draw a free-body diagram for the block of mass M_2. Be sure to label your force vectors clearly. The length of the force vectors is not important; the direction is what matters.

(c): 10 points

Calculate the magnitude of the normal force, in terms of any and/or all of M_1, M_2, g, and θ.

(d): 10 points

Calculate the magnitude of the tension in the rope, in terms of any and/or all of M_1, M_2, g, and θ.

Problem 2

The Earth makes one full rotation about its axis in approximately 24 hours, or 86,400 s. It rotates at a constant rate, and its angular speed is $\omega = \frac{2\pi}{86400} = 7.27 \times 10^{-5}$ rad/s. The Earth's radius is 6.38×10^6 m. Be sure to show all work.

(a): 8 points

What is the magnitude of the angular acceleration α of the Earth, in rad/s^2?

(b): 8 points

What is the magnitude of the centripetal acceleration of an object sitting on Earth's equator, in m/s^2?

(c): 8 points

Los Angeles does not lie on the Earth's equator. Is the magnitude of the centripetal acceleration of an object in Los Angeles greater than, less than, or equal to that of an object on the equator? Justify your answer.

(d): 8 points

Draw a free-body diagram of an object sitting on the Earth's equator. Include the net force vector in your diagram. It's the direction of your vectors that counts, not the length.

Problem 3

For each of the following statements, indicate whether the statement is true or false, and explain your reasoning.

(a): 7 points

The kinetic friction force and the normal force are always perpendicular.=

(b): 7 points

The kinetic friction force and the acceleration always point in opposite directions.

(c): 7 points

When you make a turn while riding in a car, there is a force that pushes you to the outside of the car.

(d): 7 points

An object can have a net force of zero acting on it even if the object is not at rest.