PHY6938 Proficiency Exam Fall 2002
September 13, 2002
Mechaincs

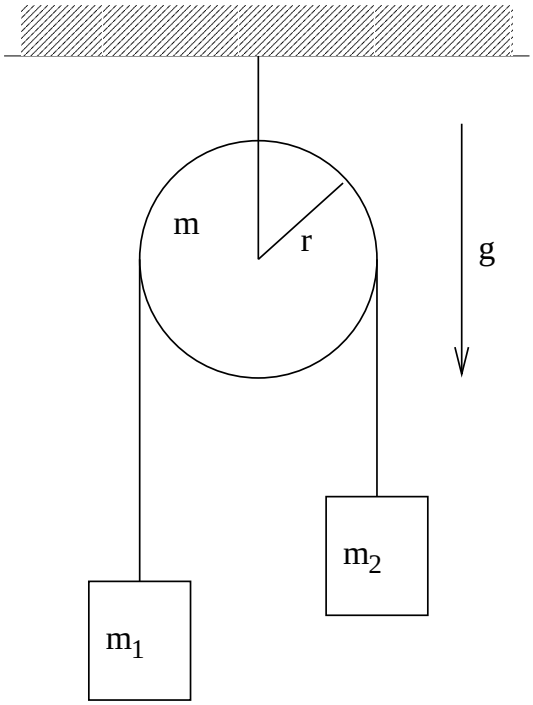
1. The system (Atwood's machine) shown in the figure consists of two masses, m_1 and m_2, attached to the ends of a string of length l which hangs over a pulley. The pulley is a uniform disk of radius r and mass m. Assume the string is massless and does not slip on the pulley.

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

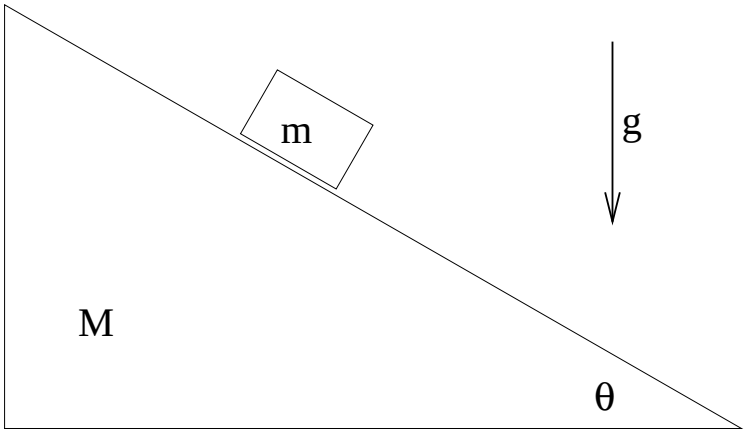
(b) Obtain the acceleration of the masses.

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

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



2. A wedge of mass $M = 4.5$ kg sits on a horizontal surface. Another mass $m = 2.3$kg sits on the sloping side of the wedge. the incline is at an angle of $31.7°$ with respect to the horizontal. All surfaces are frictionless. The mass m is released from rest on mass M, which is also initially at rest. What are the accelerations of M and m once the mass is released ?



3. A single-stage rocket of initial mass m_0 is launched vertically at constant burn rate of the fuel α. The payload mass of the rocket is m_F. The gas is exhausted at a constant speed u relative to the rocket. Neglect air resistance and assume that the acceleration of gravity is constant with height.

(a) Derive an expression for the velocity as a function of mass of the rocket.

(b) Calculate the time t_b at which the fuel is burnt out.

(c) For the first stage of a Saturn V rocket for the Apollo moon program, the initial mass is $m_0 = 2.8 \times 10^6 \text{kg}, m_F = 7 \times 10^5 \text{kg}, u = 2600 \text{m/s}$ and assume a mean thrust of 37×10^6 N. Obtain the final speed at burnout and the burnout time t_b.