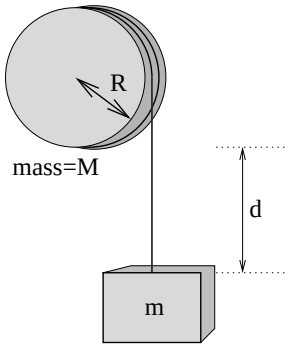
PHY6938 Proficiency Exam Spring 2003
March 28, 2003
Mechaincs

1. The drum of a winch has a mass M and a radius R. A cable wound around the drum suspends a load of mass m. The entire cable has a length L and a density (mass per unit length) λ, with a total mass $m_c = L\lambda$. The load starts from rest, at the bottom of the winch, and begins to fall toward the ground, unwinding the cable as it moves.



   (a) Write an expression for the change in potential energy of the load and the cable that has been paid out from the drum, between the initial situation and when the load has fallen a distance d.

   (b) Write an expression for the kinetic energy of the cable and the load.

   (c) Express the rotational kinetic energy of the winch in terms of I and ω and convert this expression in terms of M and v.

   (d) Using the results from above, obtain an expression for the speed of the falling load v after it has fallen the distance d, in terms of M, m, m_c, d, L and g.

2. An artificial satellite is observed to have a maximum velocity v_1 and a minimum velocity v_2 during one orbit of the earth. Find its maximum and minimum distance from the center of the earth in terms of v_1, v_2, the mass of the Earth M, and the gravitational constant G.

3. 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 ?