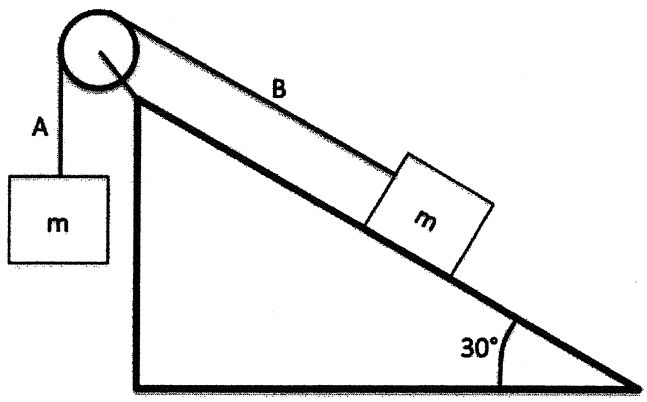
2048 H Exam 3

Name:

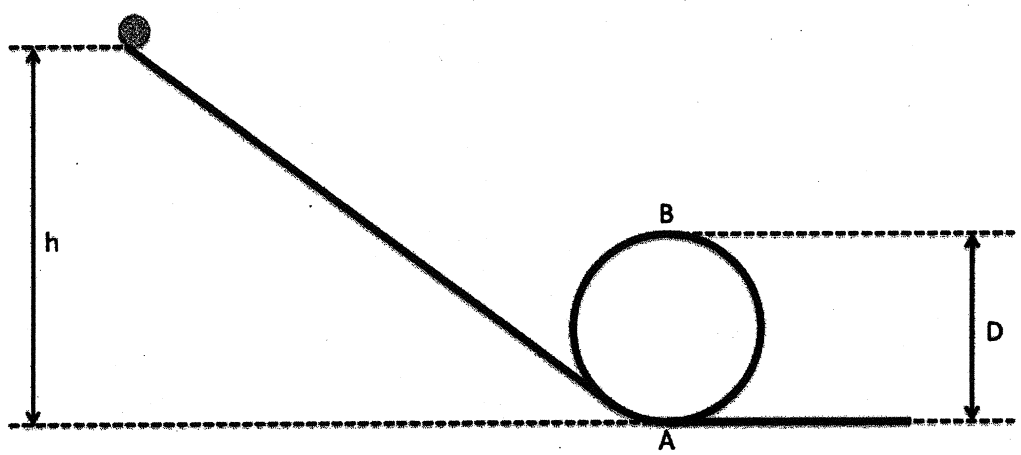
Problem 1: [28 points]

Two objects, both with mass m=10 kg, are connected by a rope and placed on a pulley attached to a triangular stage. The pulley is a uniform circle with mass M=5 kg and radius of 0.2 meters. Rope moves without slipping on the pulley and the top surface of the triangular stage is frictionless. Use the moment of inertia, $I = \frac{1}{2}MR^2$, for the pulley.

(a) Are the tensions same for the segment A and B? [3 pts]
(b) Draw the force diagrams for each objects and at the pulley (you may only show the relevant forces for the resulting motion) [6 pts]
(c) Find acceleration of the masses and indicate the direction of the motion. [12 pts]
(d) Find tension(s) for the rope [7 pts]



Problem 2 [28 points]

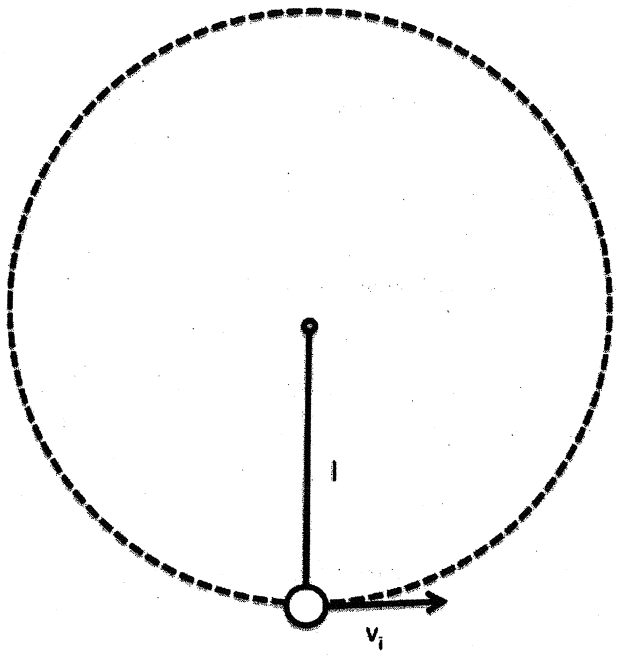


As shown above, a ball is released at height h after which it rolls down without slipping on a looped track. The loop diameter is given by D. The mass of the ball is M and the moment of inertia is given by $I = \frac{2}{5}MR^2$.

(a) Find the velocity of the ball at point A at the bottom of the slope [in terms of h, M, R, D] [7 pts]
(b) Find the velocity of the ball at point B at the top of the loop [in terms of h, M, R, and D] [7 pts]
(c) What is the condition required for the ball to make it past B? [6 pts]
(d) Find the minimum height required for the ball the make it past B. [8 pts]

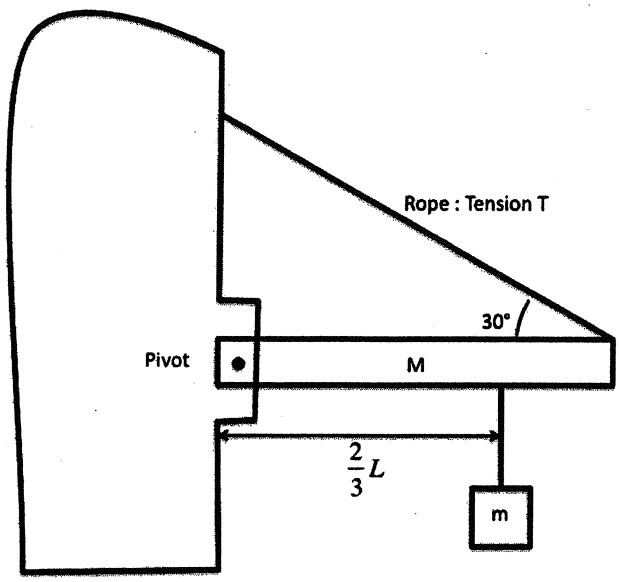
Problem 3 [28 points]

Consider a situation of a tether ball game. As drawn in the figure below a ball with mass 1 kg is attached to a rope which is 1 m. The initial velocity of the ball is 5 m/s. The rope gets wrapped to the pole and gradually decreases in length. Neglect gravity and air friction.



(a) What are the conserved quantities for *the ball* as the rope gets wrapped to the pole? [4 pts]
(b) What is the velocity of the ball when the length of the rope is 0.5 m? [8 pts]
(c) Find out the change in kinetic energy as a function of the rope length l. [8 pts]
(d) Find out the work by the pole as a function of the rope length l. [8 pts]

Problem 4 [16 pts]



A beam with mass M = 10 kg supports a mass, m=1kg, 2/3 of the length outward on its length. The length of the beam is 3 meters. The beam is supported by a pivot point in the wall and a rope with tension T.

(a) Draw force diagram for the beam [4 pts]
(b) Calculate tension [6 pts]
(c) Calculate the force on the wall at the pivot point [6 pts]