PRACTICE PROBLEMS: Final Exam, December 14 Monday, GYM, 6 to 9 PM

Multiple Choice

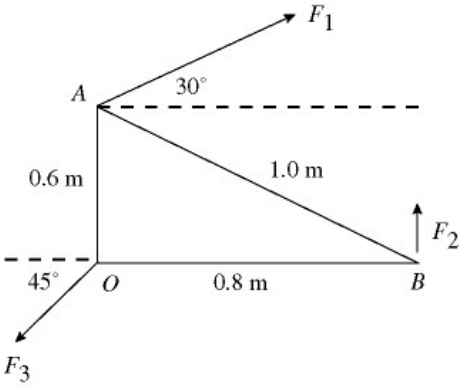
M1:

At time t = 0 s, a wheel has an angular displacement of zero radians and an angular velocity of +18 rad/s. The wheel has a constant acceleration of -0.55 rad/s^2. In this situation, the time t (after t = 0 s), at which the kinetic energy of the wheel is twice the initial value, is closest to:

a) 46 s **b)** 57 s **c)** 69 s **d)** 33 s **e)** 79 s

M2:

A light triangular plate OAB is in a horizontal plane. Three forces, F_1 = 3 N, F_2 = 1 N, and F_3 = 9 N, act on the plate, which is pivoted about a vertical axes through point O. In Figure below, the magnitude of the torque due to force F_1 about the axis through point O is closest to:

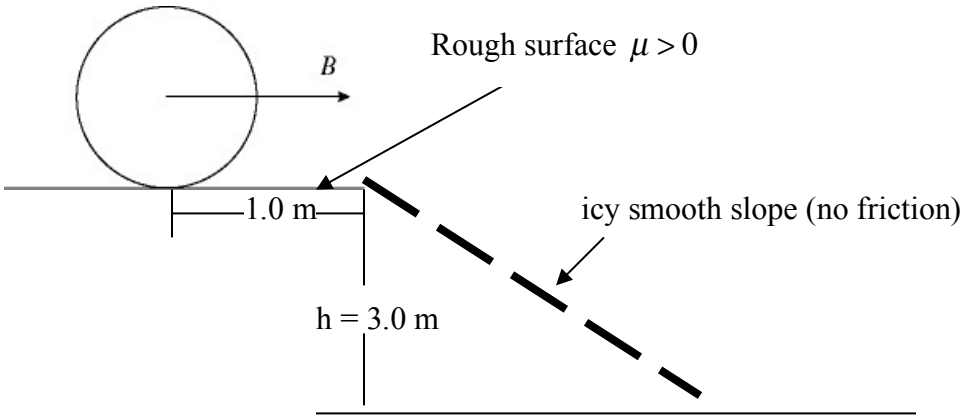


a) 1.1 N•m
b) 1.4 N•m
c) 0.90 N•m
d) 1.8 N•m
e) 1.6 N•m

PROBLEMS

Problem 1

In the figure below, a lawn roller in the form of a solid cylinder ($I = \frac{1}{2}MR^2$) is being pulled horizontally by a horizontal force, B, applied to an axle through the center of the roller, as shown in the sketch. The roller has radius R = 0.68 meters and mass M = 68 kg. The roller **rolls without slipping** on a rough surface with $\mu_s = 0.3$, and has a linear acceleration of $a = 2.5\frac{m}{s^2}$. After it rolls 1.0 m it falls down an icy slope.



a) For the part when the roller is still on the flat surface. Draw a free-body diagram that includes all forces acting on the roller. The diagram must show the direction of the **linear** and **angular acceleration**. You must briefly explain the reason for the direction of force of friction, as well as the reason why you use static and not kinetic friction. Use Newton's law for translation and rotation to find the magnitude of the force B.

b) Using the diagram from part a) determine the minimum coefficient of static friction, μ_s, in order for the roller to roll without slipping. Your answer must be smaller than 0.3, which is the value for the surfaces of the problem.

c) Find the linear and angular speed of the roller at the edge of the slope. Assume roller starts from rest without any rotational speed. **Assume that initially**, $v_0 = 0$ and $\omega_0 = 0$.

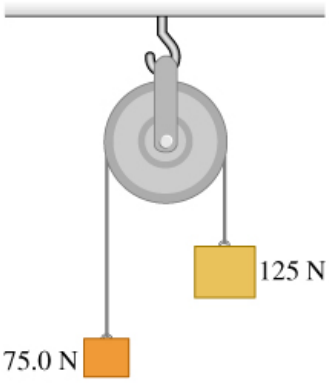
d) Use **conservation of energy** to find the linear (v) and angular speed (ω) when it reaches the bottom of the slope h = 3.0 m below. **Assume that after it reaches the edge, there is no force acting on it** (i.e. B = 0).

Problem 2

A computer disk starts rotating from rest at constant angular acceleration. If it takes 0.750 s to complete its second revolution: a) How long does it take to complete the first complete revolution; b) What is the angular acceleration? **Answer:** A) 1.81 s; **B)** 3.84 s^{-2}.

Problem 3

In the diagram below, two weights are connected by a very light string, which is passed over a 50 N solid-disk cylinder of radius 0.3 m. The 125 N accelerates downward, without the rope slipping. What force does the ceiling exerts on the pulley?



ANSWER: Using second law for linear and rotational motion, tension on the right rope is $T_{125} = 153N$; tension in the left hand side rope is $T_{75} = 91.7N$; acceleration $a = 2.18\ m \bullet s^{-2}$. Angular acceleration is $\alpha = 7.26\ rad \bullet s^{-2}$ clockwise (cw). Since the pulley does not fall down the vertical forces must add to zero, so that the **force** that the **ceiling exerts** on the **pulley** is 445 N.