P121 Exam 3 Summary Session

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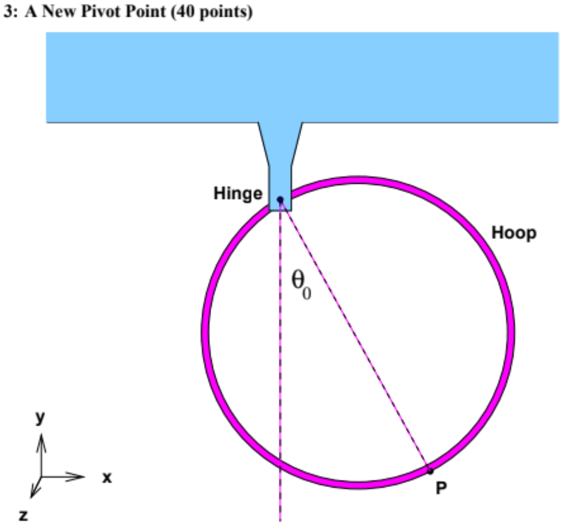
1 Learning Objectives

By the end of this session, students will be able to:

- Apply Rotational N2L to find all the forces on a body
- Find tangential/rotational acceleration on different bodies
- Use CofME to find speed and kinetic energy
- Call Corbin Covault "Bestie" (again)

2 Hoops I Did it Again

Problem 3: A New Pivot Point (40 points)



A hula-hoop of radius R and mass M is attached to an ideal hinge as shown in the figure above. The hoop is positioned at an angle θ_0 and released. Note that we define a coordinate system, where y is a vertical coordinate and z is the horizontal coordinate the points "out of the page".

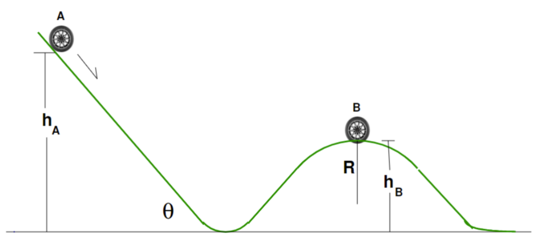
The moment of inertia of a hoop rotating about a point on the hoop's circumference is $I = 2MR^2$.

a Find the net torque on the hoop calculated about the hinge point immediately after the hoop is released. Give your answer as a vector (magnitude and direction).

b What's the angular acceleration of the hoop immediately after it has been released?

c At point P, there is a small bit of paint on the hoop. Find the maximum tangential speed of the bit of paint sometime after the hoop has been released.

3 You spin me right round, baby (right round)



A wheel of mass m and radius r is released from rest on the side of a hill at point A as shown. The height of point A (relative to the lowest point of the hill) is given as h_A. After its release, the wheel rolls with no slipping or sliding.

The wheel has a rotational inertia of $I_{cm} - Cmr^2$. The side of the hill on which the wheel is released can be likened to a ramp at an angle θ relative to the horizontal. The second hill has a radius of curvature R.

Assume $m, r, C, h_A, h_B, \theta$, and R are all given parameters, where $r << R$.

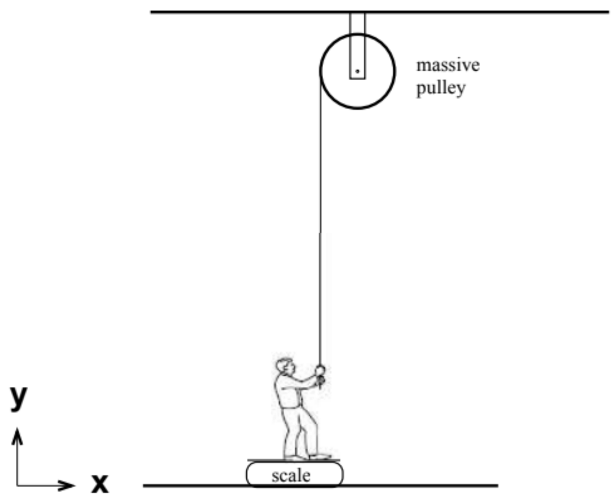
a Draw a FBD and an XFBD for the wheel at position A (immediately after release).

b What is the magnitude of the **linear acceleration** of the wheel immediately after release?

c What is the magnitude of the **Friction force** on the wheel immediately after release? (Hint: it is not zero.)

d After it is released, the wheel rolls down the first hill and up the second hill to position B, as indicated. What is the magnitude of the **Normal** force on the wheel at position B? (Hint: the velocity of the wheel at position B is not zero.)

4 Yet Another Pulley Problem (They're fun, I promise.)



Sam, a man of given mass m stands on a scale at rest. At time $t = 0$ Sam uses his arms to pulls on an ideal rope with some unspecified constant force of tension T. The rope is wound around and attached to a massive pulley mounted to the ceiling as shown. The pulley has a mass $m_p = 2m$ and the rotational inertia of the pulley is given as $I = \frac{1}{2}m_pR^2$ where R is the given radius of the pulley.

a Sam looks at the scale while pulling on the rope and sees that the scale reads exactly 3/4ths of his mass. What is the tension of the rope?

b What is the net torque applied to the pulley about the center of rotation? Express it as a vector.

c In terms of given parameters, find the total kinetic energy of the pulley as a function of time.

5 Reminders

1. MG will be holding "office hours" on Thursday from 5:30 to 7:00p.m. in Bingham 140 in case you have any questions.
2. Good luck everybody! You can do this!