Name: _____ **"Alphabetic" Student No.:**

HOMEWORK #7: Rotation I (Phys 207, Fall 2005) **DUE on Monday, 11/7**

Problem #1: Rotational Motion Variables

A wheel is initially rotating at 5 rad/s. At time t = 0 s, it begins to speed up at 10 rad/s^2. In all parts below, **show ALL WORK** beginning from the algebraic equations to obtain the numerical answers.

(a) Draw **two diagrams** of the rotating wheel when it is speeding up as shown from **above** (rotating **counterclockwise**) and from the **side**. **Label** the vector direction of the angular velocity ω and the angular acceleration α in both diagrams. Remember that a vector coming out of the page is indicated by a dot and one going into the page is indicated by a cross.

(b) Find the wheel's **angular velocity** ω after 2 s in **BOTH** rad/s and rev/s.

(c) Find the **angle** θ through which the wheel has turned after 2 s in **BOTH** radians and revolutions.

(d) Find the **speed** v of a point located at r **= 20 cm** from the rotation axis after 2 s.

(e) Find the **perpendicular acceleration** $a_{\perp}$ of the point in part (d).

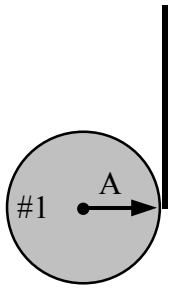
(f) Find the **parallel acceleration** $a_{//}$ of the point in part (d).

(g) Find the **total acceleration** a of the point in part (d).

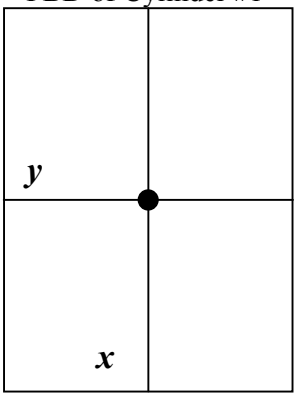
Problem #2: Rotation while Falling Vertically

As shown below, a **cylinder** (m_1) of radius A has a string wrapped around it. The string is held fixed, and the cylinder falls vertically downwards.

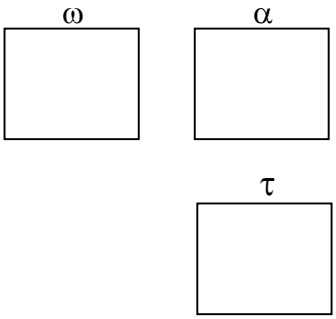
(a) Draw the **free body diagram** for cylinder #1 in the box and label all vectors using the **two subscript** notation, e.g. W_{1E} and T_{1R}. The axes are already marked in the box with $+x$ along the direction of motion. On the **picture** to the left, **DRAW the tension vector** acting on the cylinder that produces a **torque**. Note that as the cylinder falls it rotates counterclockwise and speeds up. Indicate the **directions** of ω, α, and τ in the boxes (dot = out of plane, × = into plane).



FBD of Cylinder #1



Vector Directions for Cylinder



(b) Write down $\sum F = ma$ for the cylinder using the **notation in the FBD**.

$\sum F_{1x} =$

(c) Write down $\sum \tau = I\alpha$ for the cylinder. Substitute the appropriate expression for the moment I.

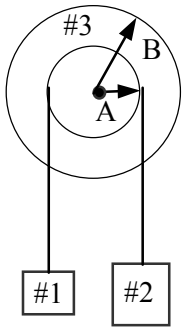
(d) Use the above equations to find the **acceleration** ***a*** of the cylinder in terms of any given variables: m_1, A, g.

(e) If the **mass** of the cylinder is **doubled**, how does that affect its **acceleration**?

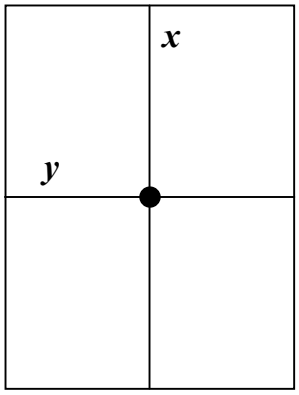
Problem #2: Two Vertical Blocks and Pulley with Mass

As shown below, **block #1** (mass m_1) is attached via a string over a mounted pulley to **block #2** (mass m_2). The rope rotates the pulley at **radius A** without slipping, and the pulley is a **disk** with **radius B** and mass m_3. Assume that Block #2 is heavier than Block #1 and the blocks accelerate such that Block #2 falls and the pulley rotates clockwise. In this case, a **positive torque** on the pulley results in a **clockwise** motion.
NOTE: This problem is analogous to Prob. 5.4 in the class notes, EXCEPT that the pulley is rotating the *opposite* direction and the radii for the torque and I are different.

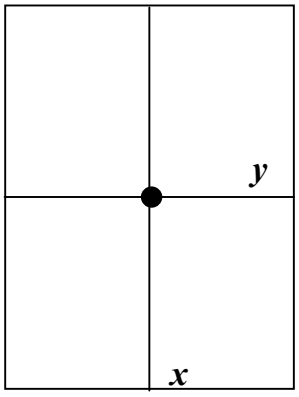
(a) Draw the **free body diagrams** for blocks #1 and #2 in the indicated boxes and label all vectors using the **two subscript** notation, e.g. W_{1E}, T_{1R}, etc. The axes are already marked in the boxes with $+x$ along the direction of motion. On the **picture** to the left, **DRAW the tension vectors** acting on the pulley (#3) that produce **torques**. Label the tension vectors producing positive and negative torques as T_{3R+} and T_{3R-}, respectively. Indicate the **directions** of ω, α, τ_-, and τ_+ in the boxes (dot = out of plane, × = into plane).



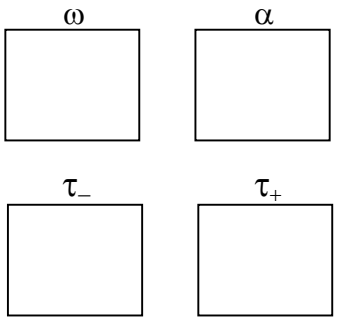
FBD of Block #1



FBD of Block #2



Vector Directions for Pulley



Due to Block #1 Due to Block #2

(b) Write down $\sum F = ma$ for blocks #1 and #2 using the **notation in the FBD's**.

$\sum F_{1x} =$

$\sum F_{2x} =$

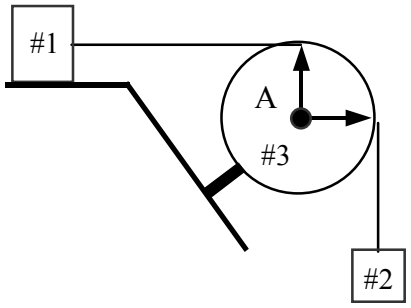
(c) Write down $\sum \tau = I\alpha$ for the pulley (#3). Substitute the appropriate expression for the moment I.

(d) Use the above equations to find the **acceleration *a*** of the blocks in terms of any given variables: m_1, m_2, A, B, and g. (Use the back of this sheet if necessary.)

Problem #4: Two Blocks (horizontal + vertical) and Pulley with Mass

As shown below, **block #1** (mass m_1) sits on a rough horizontal plane with μ_k and is attached via a string over a pulley to **block #2** (mass m_2) that is vertically hanging. The rope rotates the pulley without slipping, and the pulley is a cylindrical **disk** with **radius A** and mass m_3. Assume that Block #2 is heavier than Block #1 and the blocks accelerate such that Block #2 falls and the pulley rotates clockwise. In this case, a **positive torque** on the pulley results in a **clockwise** motion..

(a) Draw the **free body diagrams** for blocks #1 and #2 in the indicated boxes and label all vectors using the **two subscript** notation, e.g. W_{1E}, T_{1R}, f_{1S}, etc. Mark on the axes drawn in the boxes where the **+*x* and +*y* axes** are located. On the **picture** to the left, **DRAW the tension vectors** acting on the pulley (#3) that produce **torques**. Label the tension vectors producing positive and negative torques as T_{3R+} and T_{3R-}, respectively.



FBD of Block #1

FBD of Block #2

(b) Write down $\sum F = ma$ for blocks #1 and #2 using the **notation in the FBD's**.

$\sum F_{1x} =$

$\sum F_{1y} =$

$\sum F_{2x} =$

(c) Write down $\sum \tau = I\alpha$ for the pulley (#3). Substitute the appropriate expression for the moment *I*.

(d) Use the above equations to find the **acceleration *a*** of the blocks in terms of any given variables: m_1, m_2, A, and *g*. (Use the back of this sheet if necessary.)