TAM 212. Final. Dec 19, 2013.

'Quiz'

- There are 30 questions, each worth 5 points. (Quiz has just 5 questions.)
- You must not communicate with other students during this test.
- No electronic devices allowed.
- This is a 3 hour exam.
- Do not turn this page until instructed to do so.
- There are several different versions of this exam.

1. Fill in your information:

Full Name: _____

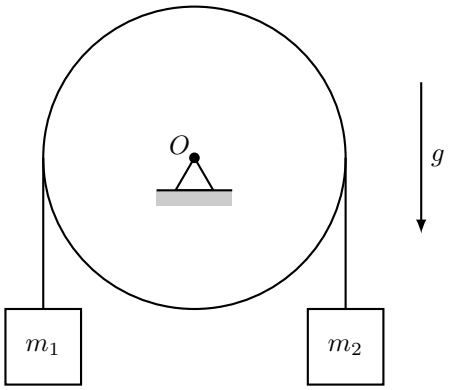
UIN (Student Number): _____

NetID: _____

2. Fill in the following answers on the Scantron form:

91. A
92. A
93. A
94. A
95. D
96. C

1. (5 points) A rigid wheel with radius r and moment of inertia I_O is pinned at point O. An inextensible massless rope connects two masses m_1 and m_2, and moves without slipping on the wheel. Gravity g acts downwards.



At the instant shown, all bodies are stationary and we have:

$$\begin{aligned} r &= 2 \text{ m} \\ I_O &= 16 \text{ kg m}^2 \\ m_1 &= 2 \text{ kg} \\ m_2 &= 4 \text{ kg} \\ g &= 10 \text{ m/s}^2 \end{aligned}$$

What is the magnitude of the angular acceleration $\vec{\alpha}$ of the wheel?

(A) $0 \text{ rad/s}^2 < \alpha < 1 \text{ rad/s}^2$

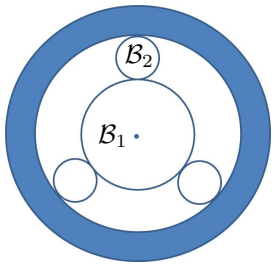
(B) $2 \text{ rad/s}^2 \leq \alpha < 3 \text{ rad/s}^2$

(C) $1 \text{ rad/s}^2 \leq \alpha < 2 \text{ rad/s}^2$

(D) $3 \text{ rad/s}^2 \leq \alpha$

(E) $\alpha = 0 \text{ rad/s}^2$

2. (5 points) A bearing is depicted below in which four discs roll without slipping inside a circular cavity which does *not* move.



At all times the body $\mathcal{B}_1$ is centered in the cavity, and at the time shown body $\mathcal{B}_2$ is directly above $\mathcal{B}_1$. The radius of $\mathcal{B}_1$ is 20 cm and the radius of $\mathcal{B}_2$ is 5 cm. If the angular velocity and angular acceleration of $\mathcal{B}_1$ are $\vec{\omega}_1 = 10\hat{k}$ rad/s and $\vec{\alpha}_1 = -\hat{k}$ rad/s^2, what is the angular acceleration $\vec{\alpha}_2$ of body $\mathcal{B}_2$?

(A) $\vec{\alpha}_2 = -4\hat{k}$ rad/sec^2.

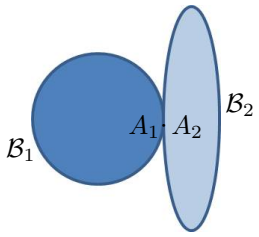
(B) $\vec{\alpha}_2 = 2\hat{k}$ rad/sec^2.

(C) $\vec{\alpha}_2 = 4\hat{k}$ rad/sec^2.

(D) $\vec{\alpha}_2 = -2\hat{k}$ rad/sec^2.

(E) $\vec{\alpha}_2 = 8\hat{k}$ rad/sec^2.

3. (5 points) Two rigid bodies bodies are in contact, rolling without slipping as seen below.



The point of contact on body $\mathcal{B}_1$ is A_1 and the point of contact on body $\mathcal{B}_2$ is A_2. In the configuration shown, which could be the acceleration vectors of these two points?

(A) $\vec{a}_{A_1} = -\hat{\jmath}$ m/s^2 and $\vec{a}_{A_2} = \hat{\jmath}$ m/s^2.

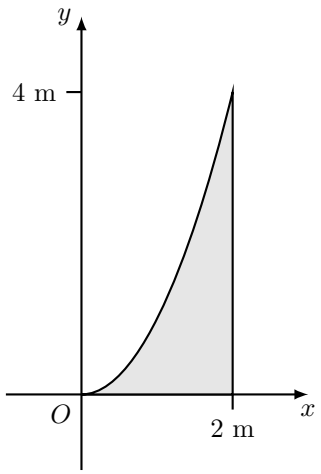
(B) $\vec{a}_{A_1} = -2\hat{\imath} + 9\hat{\jmath}$ m/s^2 and $\vec{a}_{A_2} = -2\hat{\imath} + 11\hat{\jmath}$ m/s^2.

(C) $\vec{a}_{A_1} = 5\hat{\imath} + 5\hat{\jmath}$ m/s^2 and $\vec{a}_{A_2} = -5\hat{\imath} - 5\hat{\jmath}$ m/s^2.

(D) $\vec{a}_{A_1} = -1\hat{\imath} + 10\hat{\jmath}$ m/s^2 and $\vec{a}_{A_2} = -\hat{\imath} - 10\hat{\jmath}$ m/s^2.

(E) $\vec{a}_{A_1} = -\hat{\imath} + \hat{\jmath}$ m/s^2 and $\vec{a}_{A_2} = \hat{\jmath}$ m/s^2.

4. (5 points) A body has uniform thickness in the z direction and uniform density, and its shape in the x–y plane is bounded by the curves $y = x^2/\text{m}$, $y = 0$ m, and $x = 2$ m, as shown below.



What is the x coordinate C_x of the center of mass C of the body?

(A) $1.8 \text{ m} \leq C_x$

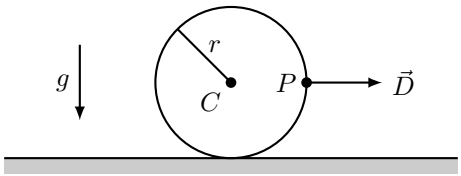
(B) $1.5 \text{ m} \leq C_x < 1.6 \text{ m}$

(C) $1.6 \text{ m} \leq C_x < 1.7 \text{ m}$

(D) $C_x < 1.5 \text{ m}$

(E) $1.7 \text{ m} \leq C_x < 1.8 \text{ m}$

5. (5 points) A circular rigid body with center of mass C, mass $m = 2$ kg, moment of inertia $I_C = 1$ kg m^2, and radius $r = 1$ m is sitting on the ground as shown. The coefficient of friction between the body and the ground is $\mu = 0.1$. A driving force $\vec{D} = 3\hat{\imath}$ N acts at point P, and gravity $g = 10$ m/s^2 acts vertically.



What is the magnitude of the friction force $\vec{F}$?

(A) $F = 4$ N

(B) $F = 2$ N

(C) $F = 1$ N

(D) $F = 3$ N

(E) $F = 0$ N