Name: ______________________________ DISC: ____________ Score: _____ / 20

Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

| Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|
| | | | |
| 10 | 10 | 5 | 5 |

1. Consider the two batons shown below. Each is made from a hollow, massless rod of length $L$ and two small equal masses of mass $m/2$. They start rotating from rest when a force $F$ is applied as shown. Let the origin pass through the axis of rotation.

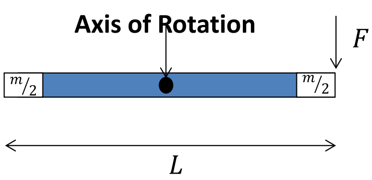


***Figure (a)—Top View***

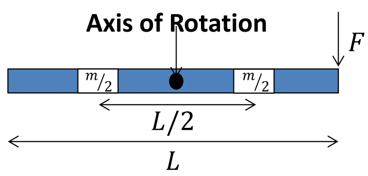


***Figure (b)—Top View***

**Table 1: Useful Information**

| MASS ($m$) | Length ($L$) | $F$ |
|---|---|---|
| $1\ kg$ | $0.5\ m$ | $2\ N$ |
| $I$ | $K$ | $\omega(t)$ |
| $I = \sum mR^2$ | $\frac{1}{2} I\, \omega^2$ | $\omega(t) = \omega_o + \alpha t$ |

$$r_{cm} = \frac{(r_1 M_1 + r_2 M_2)}{M_1 + M_2}$$

Fill in the table below:

Table (10 pts):

| QUANTITY | FIGURE (a) VALUE | FIGURE (b) VALUE |
|---|---|---|
| $I$ | | |
| $r_{cm}$ | | |
| $\tau = RF\,sin\theta = I\alpha$ | | |
| $\alpha$ | | |
| $K$ at $t = 2\ s$ | | |

2. A thin, *hollow cylinder* rolls without slipping down an inclined plane. The cylinder starts from rest at the top of the incline. The following are true about the cylinder-inclined plane system:

| **ANGLE OF INCLINE** | **LENGTH OF INCLINE** | **CYLINDER MASS** | **CYLINDER RADIUS** |
|---|---|---|---|
| $30^o$ | $1.5\ m$ | $2.5\ kg$ | $0.1\ m$ |

a. Draw a figure which describes the cylinder and inclined plane *before* the cylinder starts to roll. Remember to label all parts of the diagram, including the coordinate system.

Figure (2 pts):

b. As the cylinder rolls down the incline which of the following occur (select all correct responses):

Selections (2 pts):

i. Momentum is conserved.
ii. Potential energy is converted into kinetic energy.
iii. The cylinder will have both rotational and translational kinetic energy.

c. What is the potential energy of the cylinder at the top of the incline ($U = mgh$)?

Potential Energy (2 pts):

d. What is the total kinetic energy ($K = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$) at the bottom of the incline (hint: total energy is conserved).

Total Kinetic Energy (2 pts):

e. Using $\omega = v_{cm}/R$, find the rotational speed of the cylinder at the bottom of the ramp. For a cylindrical shell $I = MR^2$.

Rotational Speed (2 pts):