

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  $m/2$ . Each starts rotating from rest around an axis at the center when a force  $F$  is applied on one end perpendicularly.

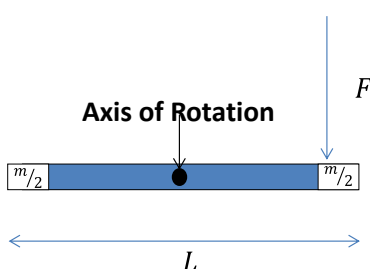


Figure (a)—Top View

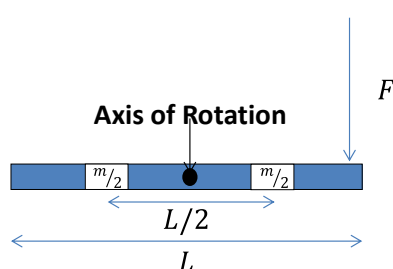


Figure (b)—Top View

Table 1: Useful Information

MASS ( $m$ )	Length ( $L$ )	$F$
2.5 kg	1.4 m	1.5 N
$I$	$K$	$\omega(t)$
$I = \sum mr^2$	$\frac{1}{2}I\omega^2$	$\omega(t) = \omega_o + at$

$$r_{cm} = \frac{(r_1 m_1 + r_2 m_2)}{m_1 + m_2}$$

Fill in the table below. Make sure to include correct units.

Table (10 pts):

QUANTITY	FIGURE (a) VALUE	FIGURE (b) VALUE
$I$		
$r_{cm}$ (measured from the left end)		
$\tau = RF \sin\theta$ $= I\alpha$		
$\alpha$		
$K$ at $t = 2\text{ s}$		

2. A thin, hollow cylinder rolls down an inclined plane without slipping. 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
$30^\circ$	3.5 m	6 kg	0.4 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.

Figure (2 pts):

Selections (2 pts):

- b. As the cylinder rolls down the incline which of the following are true (select all correct responses):
- Momentum is conserved (we consider the cylinder only).
  - Potential energy is converted into kinetic energy.
  - The cylinder will have both rotational and translational kinetic energy.

Potential Energy (2 pts):

- c. Calculate the potential energy of the cylinder at the top of the incline ( $U = mgh$ ).

Total Kinetic Energy (2 pts):

- d. Find 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).

Rotational Speed (2 pts):

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