

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.

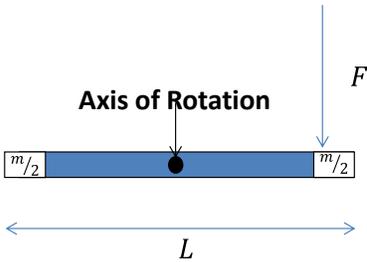


Figure (a) — Top View

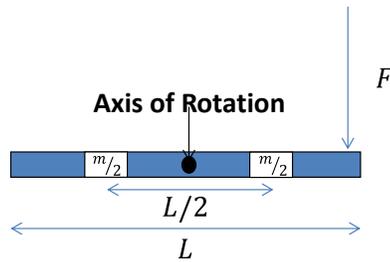


Figure (b) — Top View

Table 1: Useful Information

MASS ( $m$ )	Length ( $L$ )	$F$
0.5 kg	1.5 m	1.5 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 $t = 2 \text{ s}$		

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
$20^\circ$	2.5 m	2 kg	0.15 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):

- b. As the cylinder rolls down the incline which of the following occur (select all correct responses):
- Momentum is conserved.
  - Potential energy is converted into kinetic energy.
  - 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 ( $U = mgh$ )?

Selections (2 pts):

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):