

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.

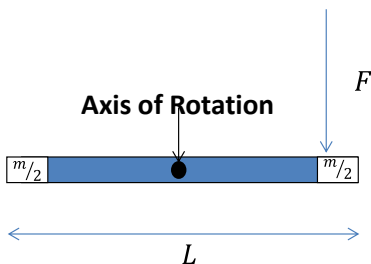


Figure (a)—Top View

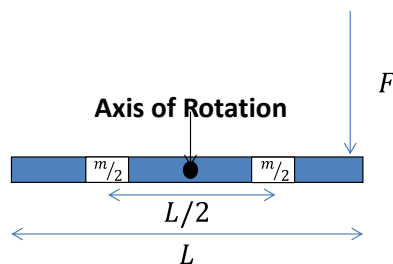


Figure (b)—Top View

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:

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

Table (10 pts):

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° | 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):