

**Midterm 1**  
**13 November 2009**

50-minute exam. Closed book/notes. No calculators are allowed.  
Solve each problem on a separate page in the correct order.

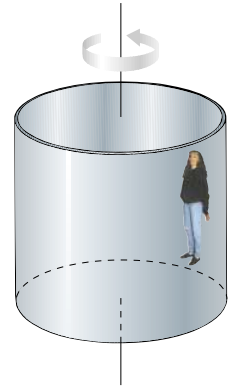
**Question 1:**

Given  $\vec{A} = 2\hat{i} + 3\hat{j} + \sqrt{3}\hat{k}$  and  $\vec{B} = 2\hat{i} - 3\hat{j} - \sqrt{3}\hat{k}$ .

- a) Find the angle between  $\vec{A}$  and  $\vec{B}$  vectors.
- b) Find a unit vector that is perpendicular to both  $\vec{A}$  and  $\vec{B}$  vectors.

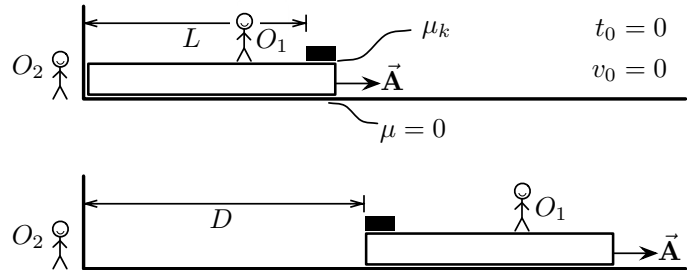
**Question 2:**

An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough such that any person inside is held up against the wall when the floor drops away. The coefficient of static friction between person and wall is  $\mu_s$ , and the radius of the cylinder is  $R$ . (a) Draw the free body diagram of the woman inside the cylinder. (b) What is the minimum velocity ( $v$ ) of the woman, in terms of  $R$ ,  $\mu_s$ , and  $g$ , to keep her from falling.



**Question 3:**

- a) Draw a free body diagram for the small mass shown as black.
- b) Find the acceleration of the small mass with respect to  $O_1$  and with respect to  $O_2$ . Show the directions explicitly.
- c) Find  $\frac{L}{D}$  ratio in terms of  $\mu_k$ ,  $g$ , and  $A$ .



**Question 4:**

Consider the force  $\vec{F} = \frac{1}{r^2}\hat{r} - \hat{\theta}$

- a) Find the work done by this force through the semi-circular path from point A to point B through path (a).
- b) Find the work done by this force through the semi-circular path from point B to point A through path (b).
- c) Is  $\vec{F}$  a conservative force? Explain it using your answers in part a) and b).

