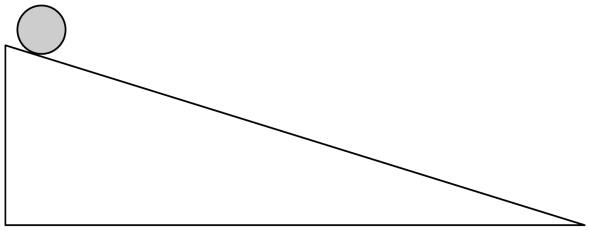
**Physics C Assignment 6.5**

*Rolling*



1. The figure shows a cylinder on an inclined plane of negligible friction. The cylinder is released from rest. Which of the following correctly describes the change in the motion of the cylinder if the incline is a rough surface?

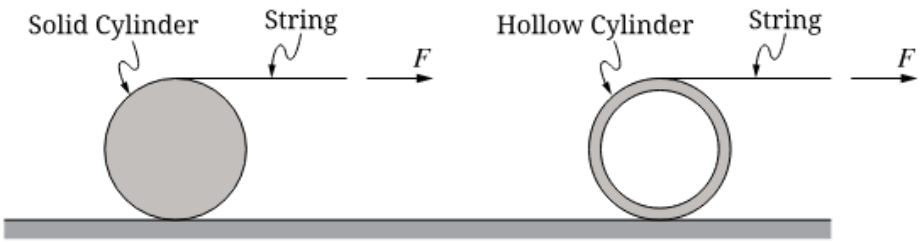
A) The cylinder rolls down both inclines, with the cylinder taking more time to reach the bottom on the rough surface.

B) The cylinder rolls down both inclines, with the cylinder taking more time to reach the bottom on the surface of negligible friction.

C) The cylinder slides down the incline of negligible friction and rolls down the incline with a rough surface.

D) The cylinder rolls down the incline of negligible friction and slides down the incline with a rough surface.

E) The cylinder rolls down both inclines in the same amount of time.

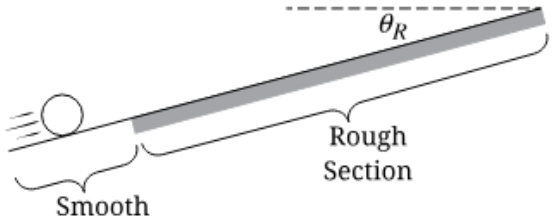



Side View

2. A solid cylinder and hollow cylinder of non-negligible thickness have the same mass $m_0$ and radius $r_0$. Both cylinders have a string wrapped around a shallow groove along their circumference so that the string can be pulled without interfering with the cylinder's motion as they roll across the table. The strings attached to each cylinder are pulled with the same force $F$, as shown in the side view figure. The rotational inertia of the solid and hollow cylinder about their centers is given by $I_S = \frac{1}{2}m_0r_0^2$ and $I_H = \frac{4}{5}m_0r_0^2$, respectively. Each cylinder rolls and accelerates without slipping while the string is pulled. What is the ratio of the translational acceleration of the center of mass of the solid cylinder to that of the hollow cylinder?

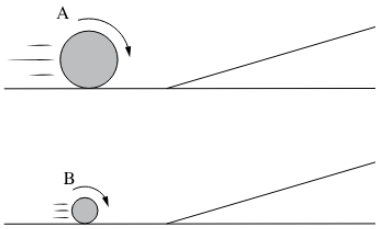
3. Wheels A and B have the same radius and roll without slipping on a horizontal surface. The translational speed and rotational kinetic energy of both wheels is the same. However, the total kinetic energy of Wheel A is less than the total kinetic energy of Wheel B. Which of the following correctly describes Wheel A in comparison to Wheel B?

A) Wheel A is more massive and on average, its mass is distributed closer to the wheel's center.
B) Wheel A is more massive and on average, its mass is distributed farther from the wheel's center.
C) Wheel A is less massive and on average, its mass is distributed closer to the wheel's center.
D) Wheel A is less massive and on average, its mass is distributed farther from the wheel's center.




4. A hollow cylinder is initially sliding without rotating up a smooth section of a ramp that makes an angle $\theta_R$ with the horizontal, as shown in the figure. The cylinder reaches a rough section of the ramp where the coefficient of kinetic friction between the cylinder and the ramp is $\mu_k$. The cylinder, which has mass $m_C$, radius $r_C$, and rotational inertia about its center of $I_C = m_C r_C^2$, starts to rotate while slipping on the rough section of the ramp. When the cylinder is rolling upward while slipping on the rough section, what is the magnitude $a$ of the cylinder's translational acceleration in terms of the magnitude $\alpha$ of its angular acceleration and its given quantities?

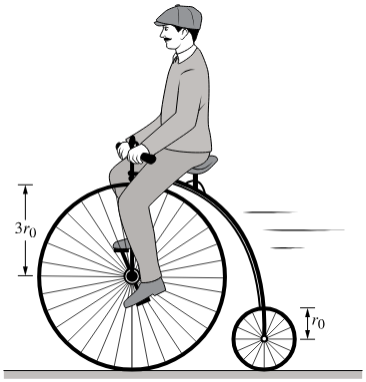
A) $\alpha r_C$
B) $\alpha r_C(\sin\theta_R + \mu_k\cos\theta_R)$
C) $\alpha r_C \frac{\sin\theta_R}{\mu_k\cos\theta_R}$
D) $\alpha r_C \frac{\sin(\theta_R) + \mu_k\cos(\theta_R)}{\mu_k\cos\theta_R}$




5. Two uniform, solid cylinders, A and B, each roll without slipping along a horizontal surface, as shown in the figure. They each then roll without slipping up a ramp and rise to a maximum height $h_A$ for Cylinder A and $h_B$ for Cylinder B. Cylinder A has twice the mass, twice the radius, and twice the initial velocity of Cylinder B, and the rotational inertia about the center of a uniform, solid cylinder of mass $m$ and radius $r$ is $I = \frac{1}{2}mr^2$. What is the ratio $\frac{h_A}{h_B}$ of the heights reached by the cylinders?

6. A sphere is held at the top of a straight ramp. When released, the sphere rolls down the ramp without slipping. Which of the following claims about the force of friction, if any, is correct?

| | **Kinetic Friction** | **Static Friction** |
|---|---|---|
| A) | Zero, performs no work | Zero, performs no work |
| B) | Zero, performs no work | Nonzero, performs no work |
| C) | Nonzero, performs negative work | Zero, performs no work |
| D) | Nonzero, performs negative work | Nonzero, performs negative work |




7. At one time, bicycles were commonly made with unequal wheel sizes. The bicycle shown in the figure has wheels with radii $3r_0$ and $r_0$ and is moving along a road with a translational speed $v_0$. The rotational inertias of the front and rear wheels are $81I_0$ and $I_0$, respectively, about the axes passing through their respective centers. If the front wheel has a rotational kinetic energy $K_{rot,F}$, what is the rotational kinetic energy of the rear wheel, in terms of $K_{rot,F}$ ?


8. A partially hollow sphere, of non-negligible thickness, is initially moving at a constant speed $v_0$ on a horizontal surface, as shown in the figure. At first, the sphere is sliding without rotating and moves with negligible friction on a smooth section of the surface. The sphere then reaches a rough section of the surface where the coefficient of kinetic friction is $\mu_k$. Sometime later, the sphere is rolling without slipping on the rough section. The sphere has a mass $m_S$, a radius $r_S$, and a rotational inertia about its center $I_S = \frac{2}{3} m_S r_S^2$. What is the final angular speed of the sphere?

9. A hollow cylinder, of non-negligible thickness, has mass $m_C$, radius $r_C$, and rotational inertia $I_C = \frac{4}{5} m_C r_C^2$. The cylinder is rolling without slipping along a horizontal surface as the cylinder's center of mass moves with a translational speed $v_0$. What is the total kinetic energy of the cylinder?

10. A solid cylinder is released from rest and rolls without slipping down an inclined plane. Which of the following quantities always increases as the cylinder rolls down the incline?

A) The translational acceleration of the center of mass of the cylinder
B) The translational speed of a point on the outside surface of the cylinder
C) The angular acceleration of the cylinder
D) The angular speed of a point on the outside surface of the cylinder