

PROBLEM 1. (15 points total)

In the park, explain why a child, standing on the swing, can swing up (make the swing higher) or swing down (make the swing lower).

PROBLEM 2. (15 points total)

In the following three cases, discuss which way needs the shortest time, the medium time, or the longest time for the same cylinder to come down from a slope:

- Rolling with slipping
- Rolling without slipping
- Slipping without rolling

PROBLEM 3. (20 points total)

A stone is thrown upward vertically from the ground at spot A with initial velocity V_0 , reaches a maximum height and falls back to ground. Neglect aerodynamic effects and let the gravity coefficient be constant g and spot A be in the north hemisphere at θ angle from the equator. Find the deflection and if is to the east or the west of spot A when the stone hits the ground.

PROBLEM 4. (30 points total)

- Of the three laws of motion due to Newton, only two are independent. Which law is contained in one of the other laws?
(5 points)
- For a particle, how is the impulse-momentum law and the work-energy relation derived from Newton's law? In what respect are the terms "impulse" and "work" fundamentally different?
(10 points)
- What is the center of percussion of a body rotating about a fixed axis? Is it possible for the center of percussion to coincide with the center of mass? If not, why and if so, how?
(10 points)
- If the free, undamped motion of a planar compound pendulum is described as simple harmonic motion, what important assumption is required?
(5 points)

PROBLEM 5. (20 point total)

What are the equation(s) of motion for small displacements of the system shown? spring K is unstretched and the force $F(t)$ is zero in the original vertical position of the system, which is at rest. Do they oscillate in unison? Explain. Draw a free-body diagram for each pendulum.

