

Problem Set 7

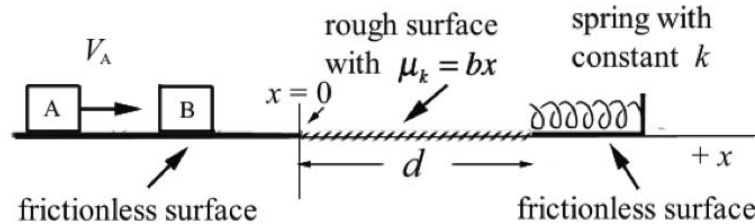
1. Object Sliding Down an Inclined Plane

An object of mass $m = 4.0$ kg, starting from rest, slides down an inclined plane of length $l = 3.0$ m. The plane is inclined by an angle of $\theta = 30^\circ$ to the ground. The coefficient of kinetic friction $\mu_k = 0.2$. At the bottom of the plane, the mass slides along a rough surface with a coefficient of kinetic friction $\mu_k = 0.3$ until it comes to rest. The goal of this problem is to find out how far the object slides along the rough surface.



- What is the work done by the friction force while the mass is sliding down the inclined plane? (Is it positive or negative?)
- What is the work done by the gravitational force while the mass is sliding down the inclined plane? (Is it positive or negative?)
- What is the kinetic energy of the mass when it just reaches the bottom of the inclined plane?
- Symbolically, what is the work done by the friction force while the mass is sliding along the ground? Is this positive or negative? Express your answer in terms of some or all of the following: m , μ_k , g , and d where d is the distance it takes the object to stop measured from the bottom of the incline.
- How far from the bottom of the inclined plane does the object slide along the rough surface?

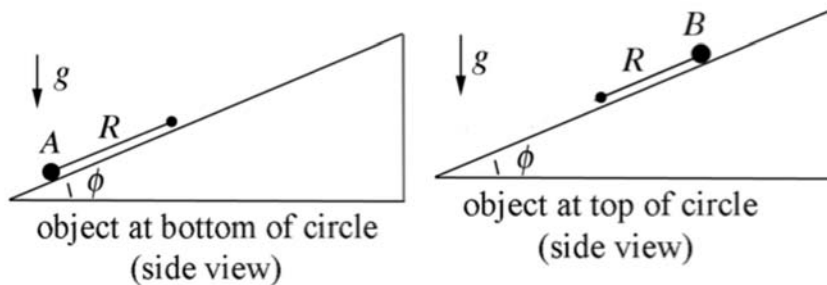
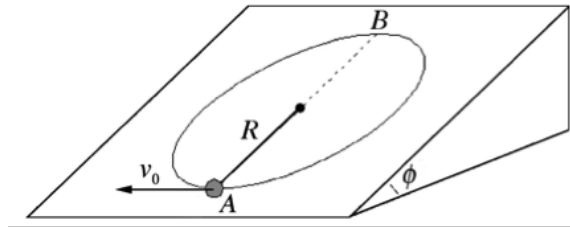
2. Collision and Sliding on a Rough Surface



Block A of mass m_A is moving horizontally with speed v_A along a frictionless surface. It collides with block B of mass m_B that is initially at rest. The two blocks stick together after the collision. At $x = 0$, block B enters a rough surface with a coefficient of kinetic friction that increases linearly with distance $\mu_k(x) = bx$ for $0 \leq x \leq d$, where b is a positive constant.

At $x = d$, block B collides with an unstretched spring with spring constant k on a frictionless surface. The downward gravitational acceleration has magnitude g . What is the distance the spring is compressed when the blocks first come to rest? Express your answer in terms of some or all of the following: v_A , b , d , g , k , m_A and m_B .

3. **Inclined plane** A body of mass m is attached to one end of a string of length R . The other end of the string is fixed on an inclined plane making an angle ϕ with the horizontal as shown in the figure. The body has speed v_0 at the bottom of the circle (point A). The body undergoes circular motion. There is a coefficient of sliding friction μ between the body and the plane. The downward acceleration of gravity is g . Express all answers in terms of m , ϕ , v_0 , g , μ and R as needed.



- (a) How much work does the friction force do on the body as it moves from the bottom of the circle (point A) to the top of the circle (point B)?
- (b) What is the tension in the string when it reaches point B? Express your answer in terms of m , ϕ , v_0 , g , μ and R as needed.

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8.01 Classical Mechanics
Fall 2016

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