ME562 – Spring 2020
Purdue University
West Lafayette, IN

Homework Set No. 5

Due date: Monday, March 9, 11:59pm

- Please include this cover sheet as the first page of your homework submission.
- Submit homework file on Gradescope.

Name _____

PUID _____

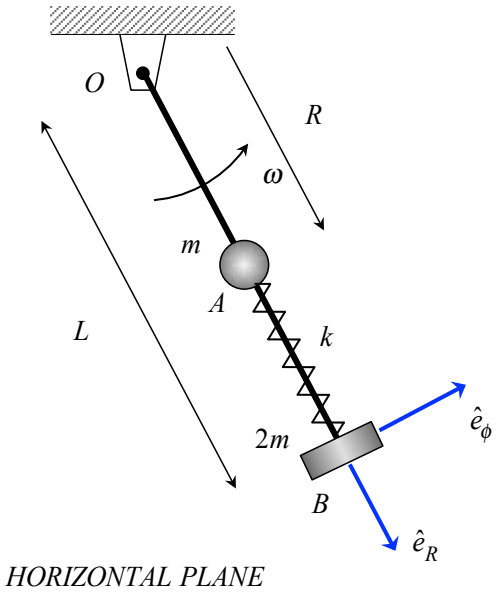
Problem 5.1 _____

Problem 5.2 _____

Problem 5.3 _____

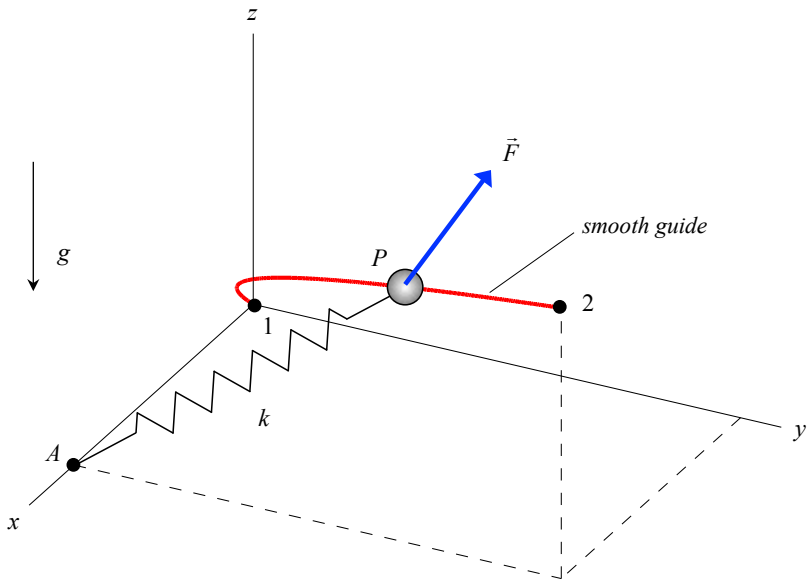
TOTAL _____

Problem 5.1 – 10 points



Particle B (of mass 2m) is attached to rigid rod OB with the rod having negligible mass and a length L. Particle A (of mass m) is allowed to slide along the smooth rod OB with a spring of stiffness k connecting A and B. The spring has an unstretched length of L/2. The system is given a set of initial conditions of $\omega = \omega_1$, $R = R_1 = L/2$ and $\dot{R}_1 = 0$. Determine the polar coordinates for the velocities of A and B when $R = R_2 = 3L/4$.

Problem 4.2 – 10 points



Particle P, having a mass of $m = 2\,kg$, is able to slide on a smooth guide, with the shape of the guide described by the following Cartesian coordinates (in cm):

$$y = \frac{3}{2}x^2$$

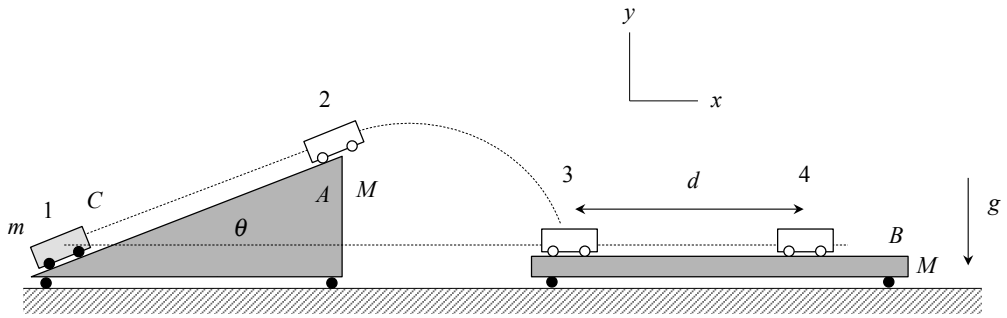
$$z = \frac{9}{2}x$$

A spring of stiffness $k = 100\,N/m$ is connected between P and the fixed point A. A force $\vec{F}$ acts on P, with the Cartesian components of this force vector given by:

$$\vec{F} = 10x\hat{i} + 20\hat{j} + 30x\hat{k} \quad \left(in\ Newtons\right)$$

Particle P starts with zero speed at position 1, with the spring compressed to half its unstretched length at this position. At 2, P is at a position with $x = 4\,cm$. Determine the speed of P at position 2.

Problem 4.3 – 10 points

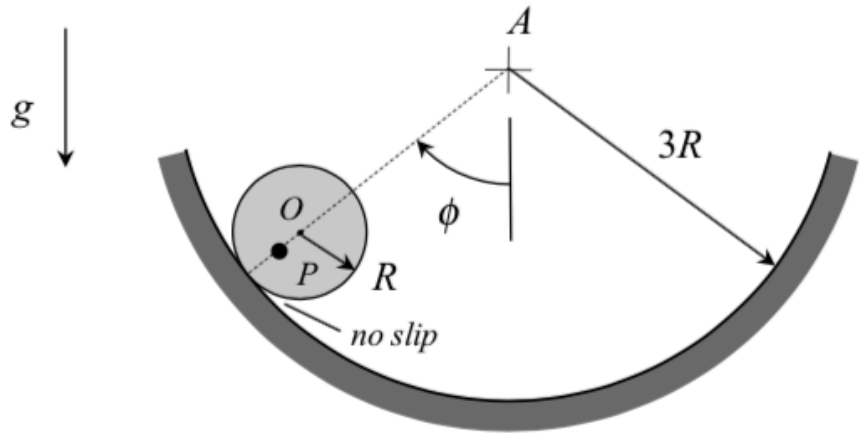


Stunt car C (of mass m) starts out at rest on a stationary inclined cart A (having a mass of M) at position 1. The car accelerates along the incline of the cart in such a way that at position 2, car C is moving with a speed of v_{rel} relative to the cart A. After position 2, the car is in free fall, landing with all wheels down on a second cart B (also of mass M) at 3. On impact with B, the car C does not bounce, and the driver immediately hits the brakes, locking the wheels. Car C skids, sliding through a distance d on cart B before coming to rest with respect to the cart at 4. Carts A and B are able to move along a smooth horizontal surface, as shown in the above figure. Treat the car as a particle at all times. Use $M = 3m$.

a) Determine the velocity of A, B and C when C has reached position 4 on cart B.

b) If μ_k is the coefficient of kinetic friction between B and C, determine the distance d along B that C slides.

Problem 4.4 – 10 points



Particle P (having a mass of m) is embedded in a disk (having negligible mass and outer radius R) rolls within slipping on the inner surface of circular bowl, with this inner surface of the bowl has a radius of $3R$. P is located at a radial distance of $R/4$ from the disk's center O. Let ϕ measure the angle between the vertical and the position of O. The system is released from rest with $\phi = 60°$ and with P on the radial line OA.

a) Determine the maximum speed of P during the subsequent motion of the disk.

b) Determine the reaction force acting on the disk by the bowl at the position corresponding to $\phi = 0$.