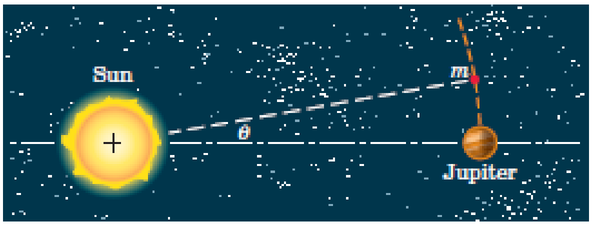
Istanbul Technical University **29.11.2018**
Faculty of Aeronautics and Astronautics
12449 DNK201E Dynamics

Sample Problems – 1

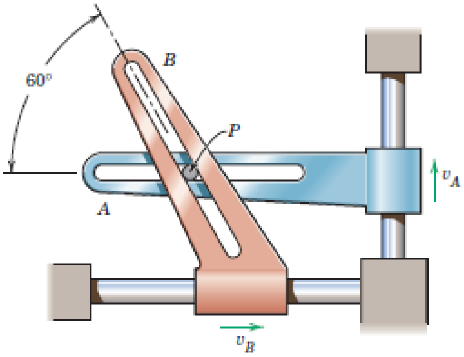
Problem 1: Determine the angle θ at which a particle in Jupiter's circular orbit experiences equal attractions from the sun and from Jupiter.



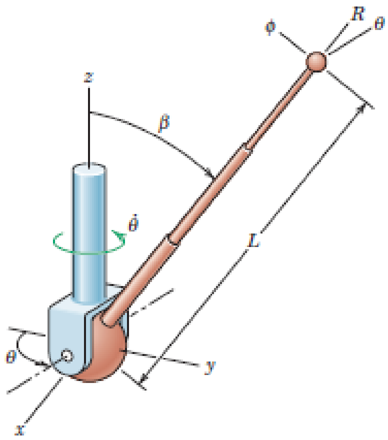
Problem 2: The motion of pin *P* is controlled by the two moving slots *A* and *B* in which the pin slides.

(a) If *B* has a velocity $v_B = 3$ m/s to the right while *A* has an upward velocity $v_A = 2$ m/s, determine the magnitude of the velocity of the pin.

(b) If *A* has a downward velocity $v_A = 1$ m/s and the velocity of the pin *P* is also 1 m/s downwards determine v_B.

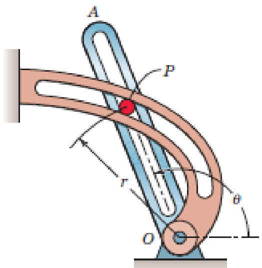


Problem 3: In a design test of the actuating mechanism for a telescoping antenna on a spacecraft, the supporting shaft rotates about the fixed *z*-axis with an angular rate . Determine the *R*-, *θ*-, and *ϕ*-components of the acceleration $\vec{a}$ of the end of the antenna at the instant when *L*=1.2m, and $\beta = 45°$, if the rates $\dot{\theta} = 2$ rad/s,$\dot{\beta} = \frac{3}{2}$ rad/s, and $\dot{L} = 0.9$ m/s are constant during the motion.

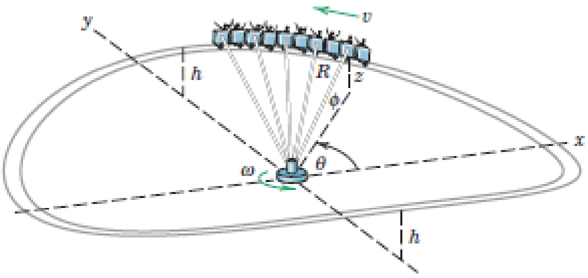


Problem 4:

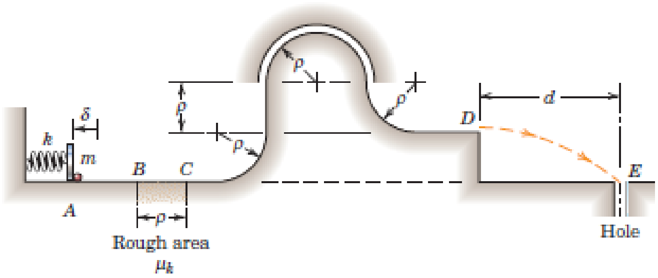
The slotted arm OA forces the small pin to move in the fixed spiral guide defined by $r = K\theta$. Arm OA starts from rest at $\theta = \pi/4$ and has a constant counterclockwise angular acceleration $\ddot{\theta} = \alpha$. Determine the magnitude of the acceleration of the pin P when $\theta = 3\pi/4$.



Problem 5: In the design of an amusement-park ride, the cars are attached to arms of length *R* which are hinged to a central rotating collar which drives the assembly about the vertical axis with a constant angular rate $\omega = \dot{\theta}$. The cars rise and fall with the track according to the relation $z = (h/2)(1 - 2\cos 2\theta)$. Find the *R*-, *θ*-, and *ϕ* -components of the velocity $\vec{v}$ of each car as it passes the position $\theta = \frac{\pi}{4} rad$.

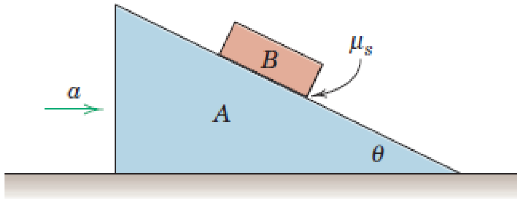


Problem 6: The object of the pinball-type game is to project the particle so that it enters the hole at *E*. When the spring is compressed and suddenly released, the particle is projected along the track, which is smooth except for the rough portion between points *B* and *C*, where the coefficient of kinetic friction is μ_k The particle becomes a projectile at oint *D*. Determine the correct spring compression δ so that the particle enters the hole at *E*. State any necessary conditions relating the lengths *d* and ρ.



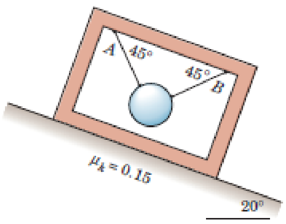
Problem 7:

The inclined block A is given a constant rightward acceleration a. Determine the range of values of θ for which block B will not slip relative to block A, regardless of how large the acceleration a is. The coefficient of static friction between the blocks is μ_s.



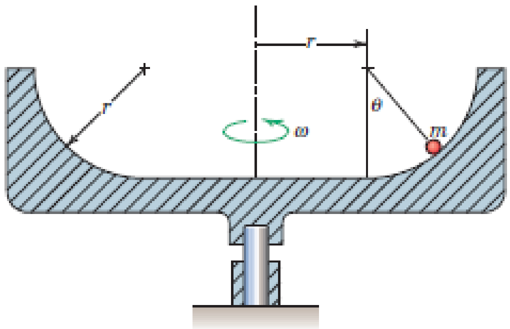
Problem 8:

The 10-kg steel sphere is suspended from the 15-kg frame which slides down the 20° incline. If the coefficient of kinetic friction between the frame and incline is 0.15, compute the tension in each of the supporting wires A and B.

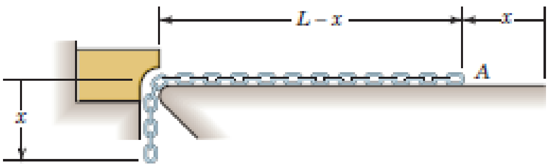


Problem 9:

The bowl-shaped device rotates about a vertical axis with a constant angular velocity ω. If the particle is observed to approach a steady-state position $\theta = 40°$ in the presence of a very small amount of friction, determine ω. The value of r is 0.2 m.

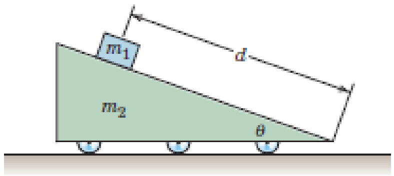


Problem 10: The chain of length L and mass ρ per unit length is released from rest on the smooth horizontal surface with a negligibly small overhang x to initiate motion. Determine

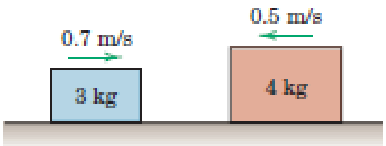


(a) the acceleration a as a function of x,
(b) the tension T in the chain at the smooth corner as a function of x, and
(c) the velocity v of the last link A as it reaches the corner.

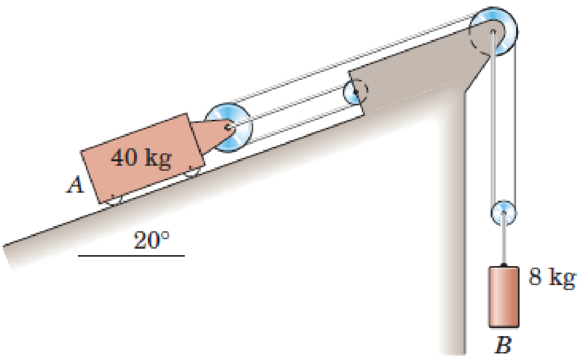
Problem 11: The system is released from rest while in the position shown. If m_1 = 0.5 kg, m_2 = 4 kg, d = 0.5 m, and $\theta = 20°$, determine the speeds of both bodies just after the block leaves the incline (before striking the horizontal surface). Neglect all friction.



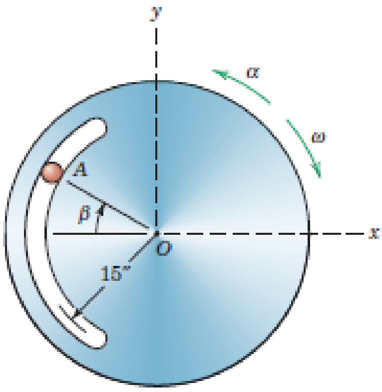
Problem 12: The two bodies have the masses and initial velocities shown in the figure. The coefficient of restitution for the collision is e = 0.3, and friction is negligible. If the time duration of the collision is 0.025 s, determine the average impact force which is exerted on the 3-kg body. Also determine loss of total kinetic energy of the system during the collision.



Problem 13: If the system is released from rest, determine the speeds of both masses after B has moved 1 m. Neglect friction and the masses of the pulleys.

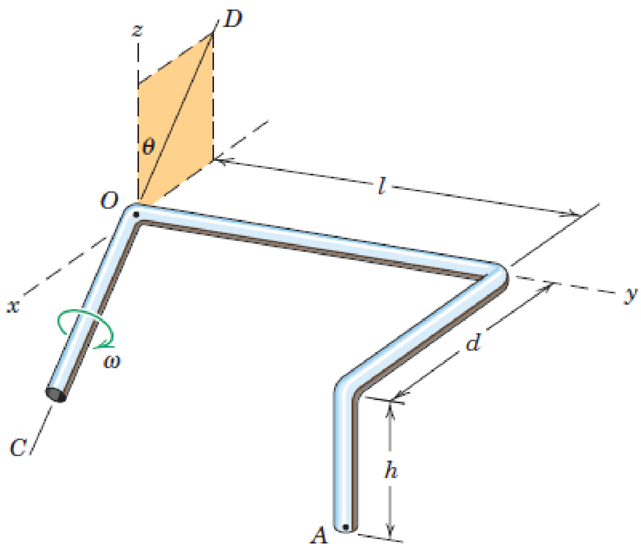


Problem 14: The disk rotates about a fixed axis through O with angular velocity $\omega = 5$ rad/s and angular acceleration α = 3 rad/s^2 in the directions shown at a certain instant. The small sphere A moves in the circular slot, and at the same instant, $\beta = 30°$ and $\dot{\beta}$ = -4 rad/s^2. Determine the absolute velocity and acceleration of A at this instant.



Problem 15:

A slender rod bent into the shape shown rotates about the fixed line CD at a constant angular rate ω. Determine the velocity and acceleration of point A.



Problem 16:

The robot shown has five degrees of rotational freedom. The x-y-z axes are attached to the base ring, which rotates about the z-axis at the rate ω_1. The arm O_1O_2 rotates about the x-axis at the rate $\omega_2 = \dot{\theta}$. The control arm O_2A rotates about axis O_1-O_2 at the rate ω_3 and about a perpendicular axis through O_2 which is momentarily parallel to the x-axis at the rate $\omega_4 = \dot{\beta}$. Finally, the jaws rotate about axis O_2-A at the rate ω_5. The magnitudes of all angular rates are constant. For the configuration shown, determine the magnitude ω of the total angular velocity of the jaws for $\theta = 60°$ and $\beta = 45°$ if $\omega_1 = 2$ rad/s, $\dot{\theta} = 1.5$ rad/s, and $\omega_3 = \omega_4 = \omega_5 = 0$. Also express the angular acceleration $\boldsymbol{\alpha}$ of arm O_1O_2 as a vector.