K.N. Toosi University of Technology
Faculty of Mechanical Engineering

Issued on Monday Nov. 2^{nd}
(Aban 11^{th} 1396)
Due on Monday Nov. 13^{th}
(Aban 22^{nd} 1396)

Advanced Dynamics

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Problem Set 3

1928
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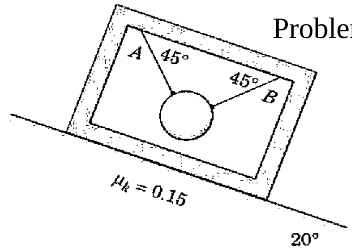
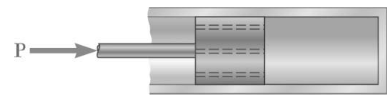
1 – The 10-kg steel sphere is suspended from the 15-frame which slides down the 20° incline. If the coefficient of kinetic friction between the frame and incline is 0.15 compute the tension in each of the supporting wires A and B.



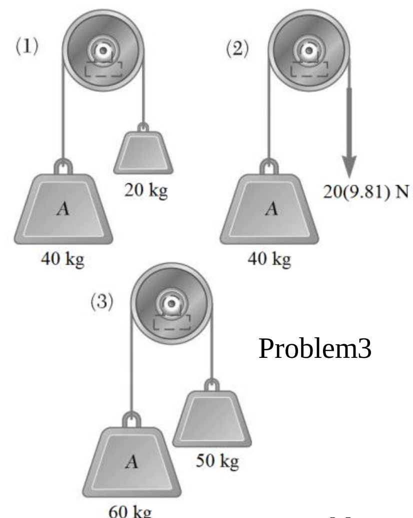
Problem1

2 – A constant force P is applied to a piston and rod of total mass m to make them move in a cylinder filled with oil. As the piston moves, the oil is forced through orifices in the piston and exerts on the piston a force of magnitude kv in a direction opposite to the motion of the piston. Knowing that the piston starts from rest at t = 0 and x = 0, show that the equation relating x, v, and t, where x is the distance traveled by the piston and v is the speed of the piston, is linear in each of these variables.

Problem2

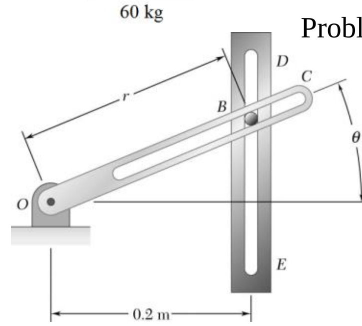


3 – Each of the systems shown is initially at rest. Neglecting axle friction and the masses of the pulleys, determine for each system (a) the acceleration of block A, (b) the velocity of block A after it has moved through 2 m, (c) the time required for block A to reach a velocity of 6 m/s.



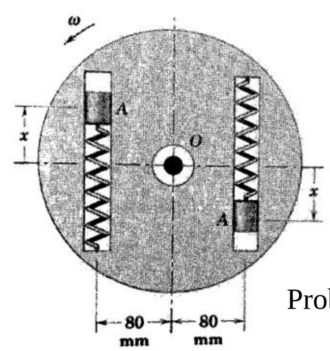
Problem3

4 – The 100-g pin B slides along the slot in the rotating arm OC and along the slot DE which is cut in a fixed horizontal plate. Neglecting friction and knowing that rod OC rotates at the constant rate $\dot{\theta}$=12 rad/s, determine for any given value of (a) the radial and transverse components of the resultant force F exerted on pin B, (b) the forces P and Q exerted on pin B by rod OC and the wall of slot DE, respectively.



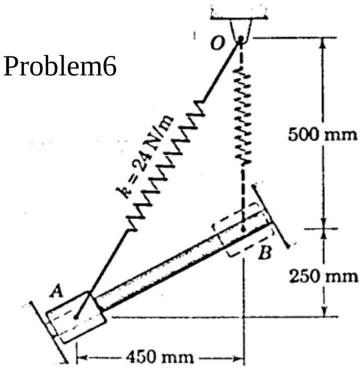
Problem4

5 – The disk shown in the figure rotates in a horizontal plane around the point O and its angular velocity gradually increases. Initially, two 0.5-kg masses were in the distance of x = 25 mm and the spring forces were zero. If the disk rotates with constant angular velocity of 240 rpm, determine (a) the value of x and (b) the magnitude N of the normal forces exerted by the walls on the masses. Both springs has the same stiffness of 400 N/m. Neglect the friction between masses and the walls.



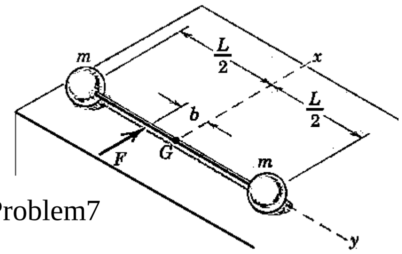
Problem5

6 – The 0.9-kg slider is released from rest at point A and slides along the guide in absence of friction. The spring stiffness is 24 N/m and its unstretched length is 375 mm. Determine the velocity at which the slider collide with point B.



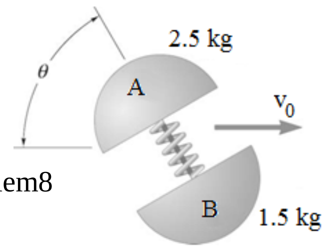
Problem6

7 – Two steel ball, each of masses m, are welded to a light rod of length L and negligible mass and are initially at rest on a smooth horizontal surface. A horizontal force of magnitude F is suddenly applied to the rod as shown. Determine (a) the instantaneous acceleration of the mass center G, and (b) the corresponding rate $\ddot{\theta}$ at which the angular velocity of the assembly about G is changing with time.



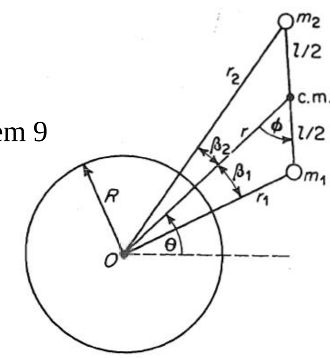
Problem7

8 – Two hemispheres are held together by a cord which maintains a spring under compression (the spring is not attached to the hemispheres). The potential energy of the compressed spring is 120 J and the assembly has an initial velocity v_0 of magnitude v_0 = 8 m/s. Knowing that the cord is severed when θ = 30°, causing the hemispheres to fly apart, determine the resulting velocity of each hemisphere.



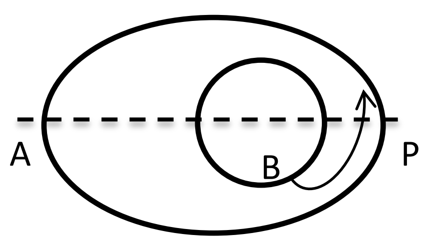
Problem8

9 –Two particles, each of mass *m*, are connected by a massless rod of length *l*. The center of mass of this system is in a circular orbit of radius *r* about the earth. Calculate the frequency of small oscillations of the coordinate φ in the plane of the orbit. Assume that $l \ll r$ and $|\varphi| \ll 1$



Problem 9

10 – A satellite have been launched from point B on equator, and placed in an elliptical path which its minimum and maximum height from the earth is 2000 km and 4000 km respectively. Calculate (a) the satellite velocity at the apexes of the path, (b) the velocity at height of 2500 km, and (c) the period of motion.



Problem 10