Note: refer to the figures on bottom for the corresponding problems

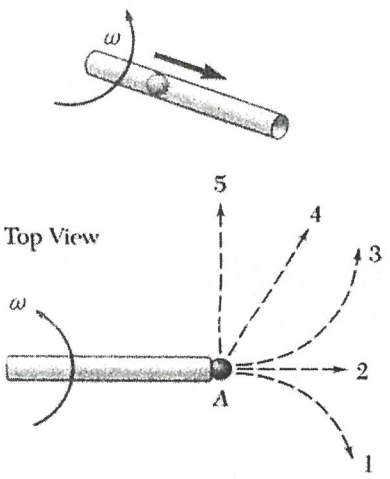
1. [16 points]

(1) Marble A is placed in a hollow tube, and the tube is swung in a horizontal plane causing the marble to be thrown out. As viewed from the top, which of the following choices best describes the path of the marble after leaving the tube? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5

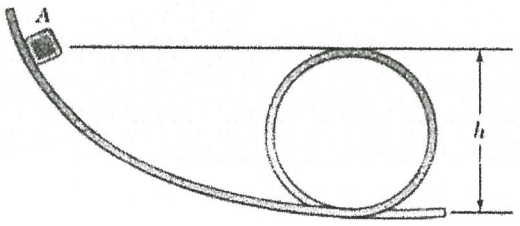
(2) Block *A* is released from rest and slides down the frictionless ramp to the loop. The maximum height *h* of the loop is the same as the initial height of the block. Will *A* make it completely around the loop without losing contact with the track? Why?

(3) The expected damages associated with two types of perfectly plastic collisions are to be compared. In the first case, two identical cars traveling at the same speed impact each other head on. In the second case, the car impacts a massive concrete wall. In which case would you expect the car to be more damaged? (a) Case 1 (b) Case 2 (c) The same damage in each case.

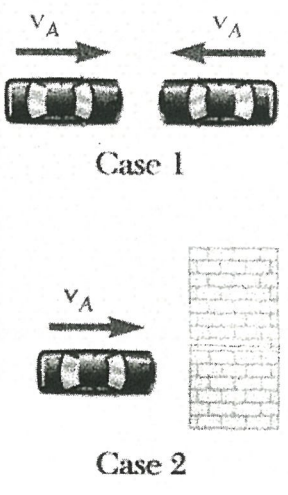
(4) Three uniform rods, *ABC*, *DCE* and *FGH* are connected as shown. Which of the following statements are true? (a) $\omega_{ABC} = \omega_{DCE} = \omega_{FGH}$ (b) $\omega_{DCE} > \omega_{ABC} > \omega_{FGH}$ (c) $\omega_{DCE} < \omega_{ABC} < \omega_{FGH}$ (d) $\omega_{ABC} > \omega_{DCE} > \omega_{FGH}$ (e) $\omega_{FGH} = \omega_{DCE} < \omega_{ABC}$.



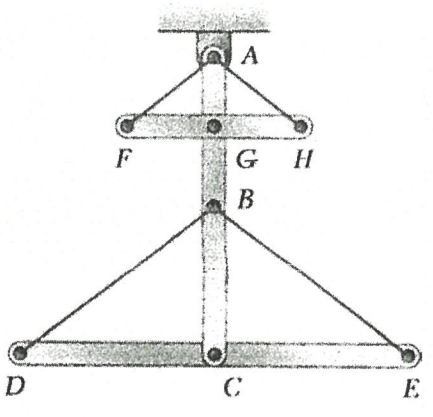
Problem 1.1



Problem 1.2



Problem 1.3

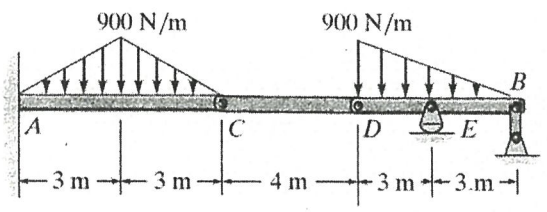


Problem 1.4

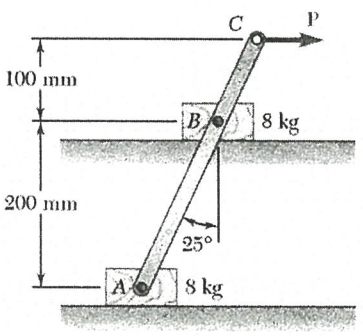
2. [15 points] Determine the reactions at the supports at *A*, *E*, and *B* of the compound beam. (Please indicate the directions and angles if necessary)

3. [14 points] Two 8-kg blocks *A* and *B* resting on shelves are connected by a rod of negligible mass. Knowing that the magnitude of a horizontal force **P** applied at *C* is slowly increased from zero, determine the value of **P** for which motion occurs, and what that motion is, when the coefficient of static friction between all surfaces is (*a*) $\mu_s = 0.40$, (*b*) $\mu_s = 0.50$.

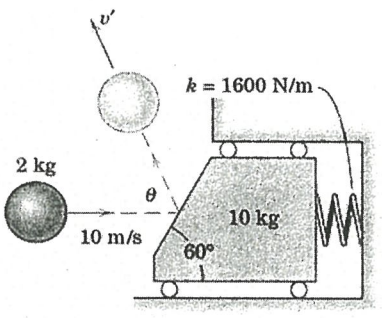
4. [15 points] The 2-kg sphere is projected horizontally with a velocity of 10 m/s against the 10-kg carriage which is backed up by the spring with stiffness of 1600 N/m. The carriage is initially at rest with the spring uncompressed. If the coefficient of reconstitution is 0.6, calculate (*a*) the rebound velocity *v'*, (*b*) the rebound angle θ, and (*c*) the maximum travel δ of the carriage after impact.



Problem 2



Problem 3



Problem 4

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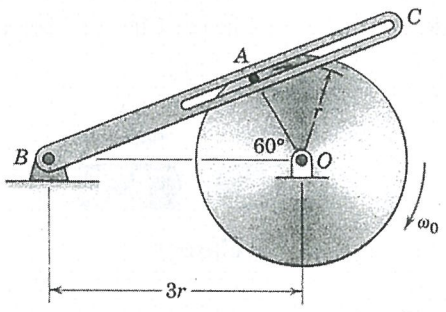
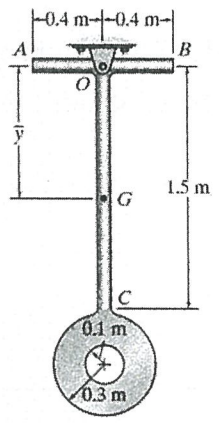
5. [20 points] The disk rotates about a fixed axis through point *O* with a clockwise angular velocity $\omega_0 = 20\ \text{rad/s}$ and a counterclockwise angular acceleration $\alpha_0 = 5\ \text{rad/s}^2$ at the instant under consideration. The value of *r* is 200 mm. Pin *A* is fixed to the disk but slides freely within the slotted member *BC*. Determine (*a*) the velocity and acceleration of *A* relative to slotted member *BC* and (*b*) the angular velocity and angular acceleration of *BC*. (Each answer for 5 pt)

6. [20 points] The pendulum consists of two slender rods *AB* and *OC* which have a mass of 3 kg/m. The thin plate has a mass of 12 kg/m. (*a*) Determine the location $\bar{y}$ of the center of mass *G* of the pendulum, and (*b*) calculate the moment of inertia of the pendulum about an axis perpendicular to the page and passing through *G*. (Hint: for a slender rod, moment of inertia $\bar{I} = \frac{1}{12}mL^2$)



Problem 5



Problem 6

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