1. (25%) Two identical cars were running on different lanes of a freeway. At some instant (assume that it is $t=0$), their velocities and relative positions are shown in Fig. 1, where $v_A = 100.8 km/hr\,(28 m/\sec)$, $v_B = 90 km/hr\,(25 m/\sec)$, and $\theta = 5.73° = 0.1 rad$. Suppose at that time, Car B changed to the left lane and both cars kept their velocities. The cars are assumed to be of rectangular shape with length $l = 3 m$, width $w = 1.5 m$, and height $h = 1 m$. The mass center of the car is at its geometric center.

(a) (5%) When will the two cars collide? Assume that both cars did not rotate before the collision. **Note:** You can use the approximation $\sin\theta \approx \theta$ and $\cos\theta \approx 1$.

(b) (5%) Please plot the relative position of the two cars at the time of collision.

(c) (15%) Please describe a procedure on how you will find the motion of the two cars after the collision. **Note:** You do **not** need to find the motion of the two cars. Only a procedure (including the physical laws and principles that need to be used) is required.

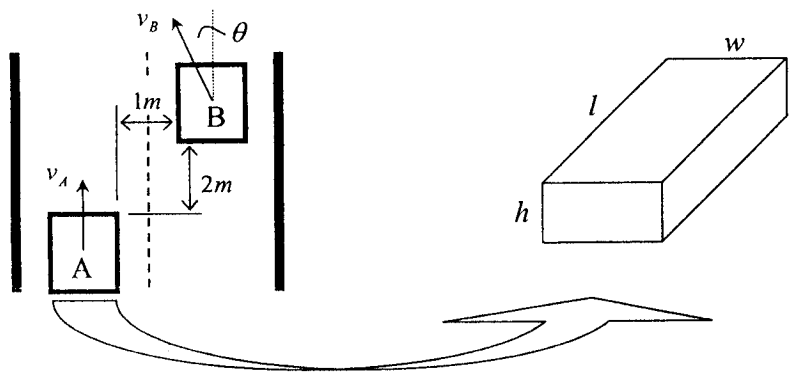


Fig. 1

2. (25%) The smooth 1-kg block $B$ in Fig.2 has a peg $P$ through its center which passes through the slot in arm $OA$. If the arm rotates in the vertical plane at a constant rate $\dot{\theta} = 2$ rad/s, determine the force that the arm exerts on the peg at the instant $\theta = 45°$. Neglect friction.

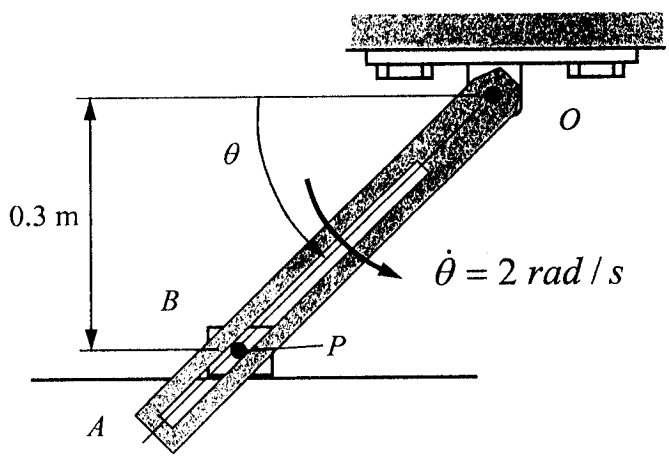


Fig. 2