I. Answer the following questions:

i. For a three-dimensional Cartesian coordinates, when its x-y plane is rotating about its z-axis with angular velocity $\vec{\omega} = \omega_z \vec{k}$, try to derive the time rates of unit vectors for both of x, y axes are

$$d\vec{i}/dt = \vec{\omega} \times \vec{i} = \omega_z \vec{j}, \text{ and } d\vec{j}/dt = \vec{\omega} \times \vec{j} = \omega_z \vec{i}$$

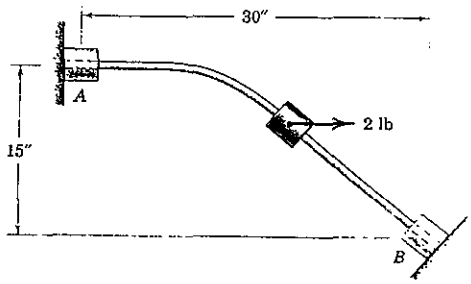
Where $\vec{i}, \vec{j},$ and $\vec{k}$ are the unit vectors of x, y and z axes respectively, and ω_z is the angular speed around z axis (10%).

ii. When a wheel is rolling without slipping in one direction along x-axis on a plane surface, try to (1) define the instantaneous center of zero velocity, the body and space centrodes involved. (2) To figure out the relation between the above two centrodes (15%).

iii. When a particle is moving in a space curve, try to describe what is the Coriollis acceleration. By the way, try to explain the causes to produce this acceleration (10%).

iv. For a rigid body in plane motion, can you define (1) the corresponding plane of motion, and (2) describe in kinematical situation translation motion(10%)

II. The 1.5-lb collar slides with negligible friction on the fixed rod in the vertical plane. If the collar starts from rest at A under the action of the constant 2-lb horizontal force, calculate its velocity v as it hits the stop at B (10%).



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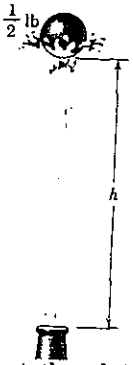
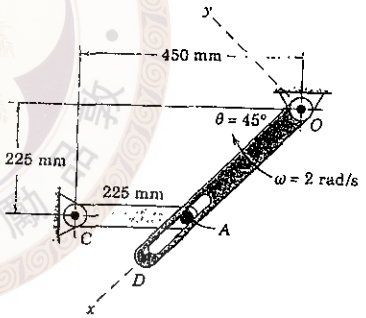
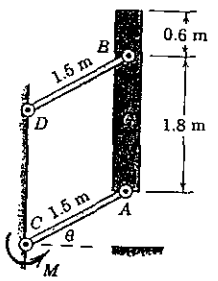
III. **The 8-oz ball is supported by the vertical stream of fresh water which issues from the 1/2 inch.-diameter nozzle with a velocity of 35ft/sec. Calculate the height h of the ball above the nozzle. Assume that the stream remains intact and there is no energy lost in the jet stream (15 %)**



IV. **The pin A of the hinged link AC is confined to move in the rotation slot of link OD. The angular velocity of OD is $\omega = 2$ rad/s clockwise and is constant for the interval of motion concerned. For the position where $\theta = 45^{o}$ with AC horizontal, determine the velocity of pin A and the velocity of A relative to the rotating slot in OD (15%).**



V. **The vertical bar AB has a mass of 150kg with center of mass G midway between the ends. The bar is elevated from rest at $\theta = 0$ by means of the parallel links of negligible mass, with a constant couple M=5kN.m applied to the lower link at C. Determine the angular acceleration α of the links as a function of θ and find the force B in the link DB at the instant when $\theta = 30^{\circ}$ (15%).**



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