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1. (20%) Grip a baseball bat and rotate it back and forth horizontally. Grip it at the opposite end and rotate it as before. Compare the difficulty. Why? Explain.

2. (20%) A skier of weight W slides down a small mountain side along a spiral path which may be approximated by the system shown in Figure 1. The spiral path is properly banked to keep the skier form 'flying off' as a projectile. His angular position is expressed by the equation $\theta = 1.2t$ where t is in seconds and θ in radians. The skier moves a distance q, measured along the z axis, every time he makes on complete revolution. In terms of t, D, q, W, and H, determine the components F_r, F_θ, and F_z of the force exerted by the path on the skier for any position along the spiral path. Find these force components for the case where $W = 750$ N, $q = 20$ m, $D = 300$ m, $H = 400$ m, and $t = 10$ s.

3. (20%) It is desired to drive a pile of weight $W_p = 3000$ kg into the ground by dropping a hammer of weight $W_H = 250$ kg a distance $h = 5$ m onto the pile as shown in Figure 2. Determine the distance that the pile is driven into the ground by a single blow of the hammer, if it is assumed that the ground provides a constant resisting force of 12500 kg. Assume the impact to be perfectly plastic.

4. (20%) The assembly shown in Figure 3 rotates about the vertical shaft AB which lies along the Z axis so that, at the instant depicted, the angular velocity is $\omega = 10$ rad/s and the angular acceleration is $\alpha = 75$ rad/s^2 as shown. The collar C slides freely on arm OD which is rigidly attached to shaft AB and, in the position as shown, the relative linear velocity $\mathbf{v}_R$ and relative linear acceleration $\mathbf{a}_R$ of the collar with respect to arm OD have magnitudes of 30 cm/s and 200 cm/s^2, respectively. For the position shown, determine (a) the absolute linear velocity of the collar and (b) the absolute linear acceleration of the collar.

5. (20%) Explain (a) Principle of conservation of mechanical energy, (b) principle of angular impulse and momentum, (c) conservation of momentum, and (d) parallel axis theorem.

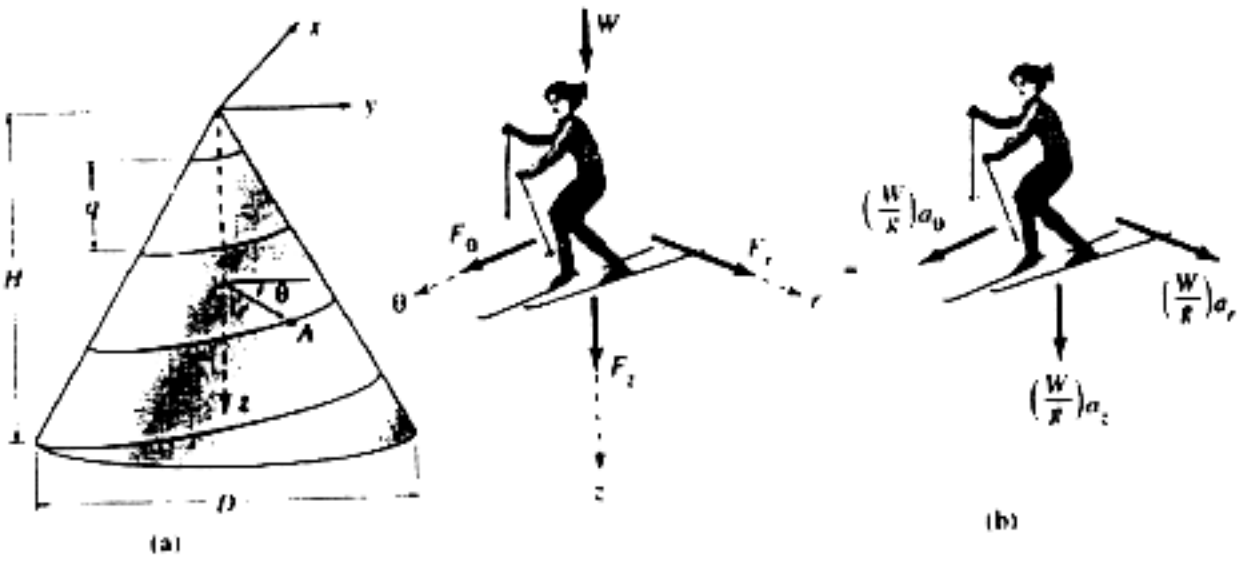

Figure 1

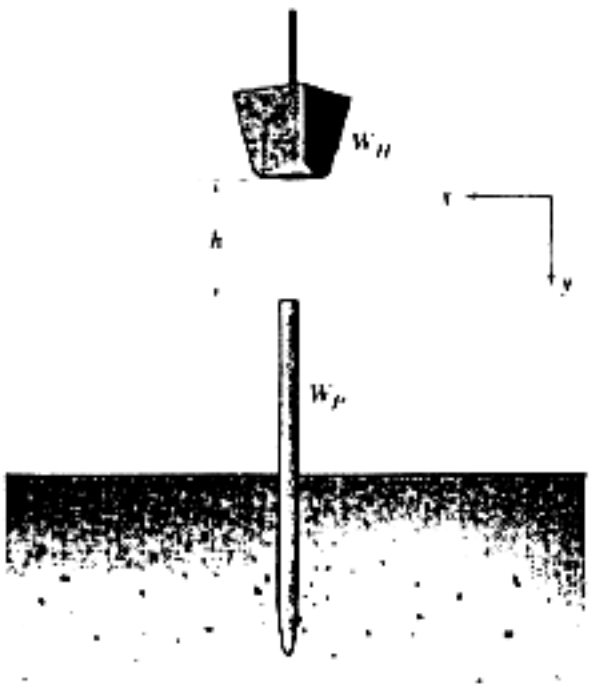

Figure 2

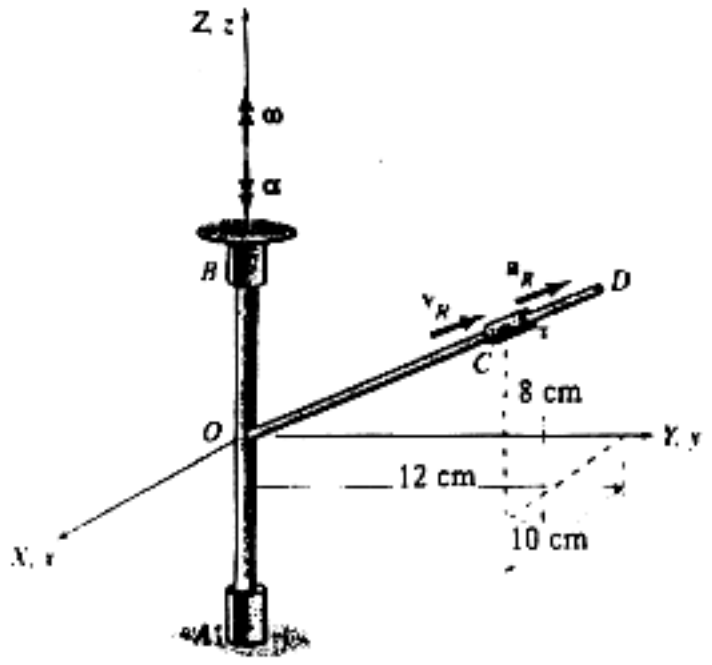

Figure 3