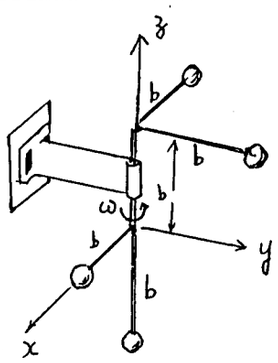
1. Explain the following terminology in mechanics . (20%)
   a) Conservation force
   b) Conservation of angular momentum
   c) Dynamic equilibrium
   d) D'Alembert's principle
   e) The principle of virtual work (rigid & deformable body)

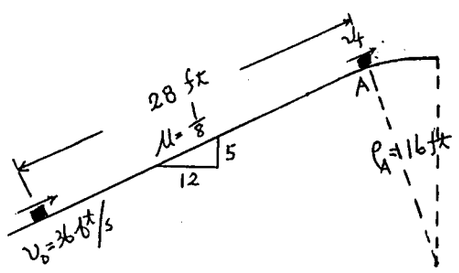
2. Each of the metal sphere has a mass m and a diameter which is small compared with the dimension b. Compute the values of the principal moments of inertia and determine the direction cosines for each of the principal axes of inertia.



(20%)

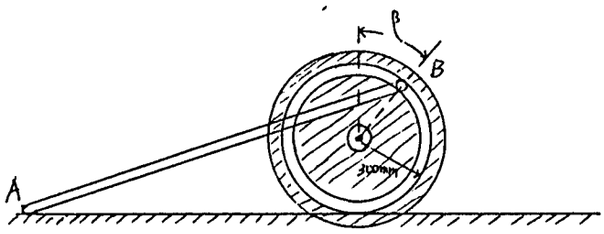
Note: Select 3 problems from following 5 optional problems to answer
(Only 3 problems can be selceted; additional selections will not be scored)

3. Calculate the velocity of the body (weight W) as it reaches point A, and the normal force exerted by the plane on the body at this point noting that the path radius of curvature is 16 ft. (optional)



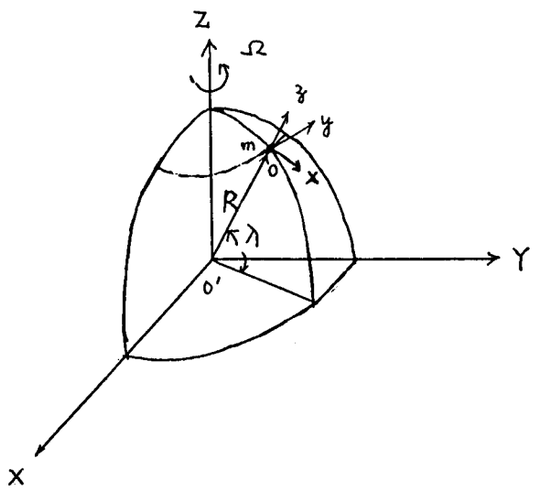
(20%)

4. The flanged wheel shown rolls to the right with a constant velocity of 1.5m/s. Knowing that rod AB is 1.2 m long, determine the velocity of A and the angular velocity of the rod when (a) $\beta = 0^\circ$ (b) $\beta = 90^\circ$ (optional)



(20%)

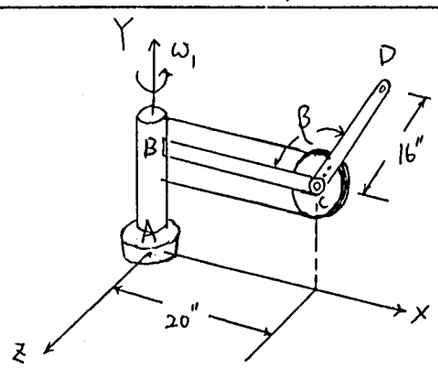
5. Derive the equations of motion for the free trajectory of a particle of mass m using generalized coordinate x, y, z which give its position relative to axes fixed on the earth's surface as shown. Identify the gyroscopic terms in your equations.
Assume: center of earth fixed, no air resistance, weight is constant = mg, neglect Ω^2 terms.
(Using any method you like to derive the equations) (optional)



(20%)

6. The body AB and rod BC of the robot conpoment shown rotate at the constant rate $\omega_1 = 0.60$ rad/s about Y axis. Simultaneously a wire and pulley control causes arm CD to rotate about C at the constant rate $\omega_2 = d\beta/dt = 0.45$ rad/s. Knowing that $\beta = 120^\circ$, determine
a) the angular acceleration of arm CD,
b) the acceleration of D.
(optional)

(20%)



7. The 100 kg uniform rod AB rests on a frictionless floor, while end A is attached to a horizontal cable AC and B is subjected to an external force 1500 N. Knowing that at the instant shown the external force causes the rod start from rest, determine the tension force of a cable and angular acceleration of a rod. (optional)

(20%)