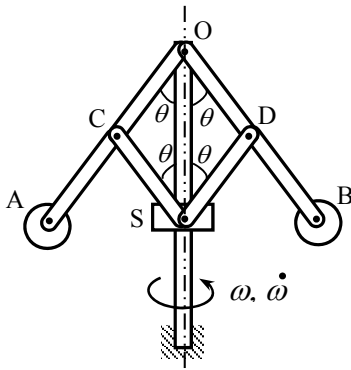


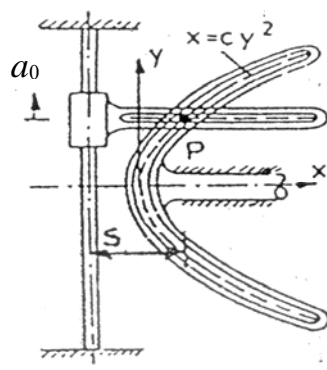
**Part A:**

- 1) A point moves along a logarithmic spiral in the x-y plane, given by the equation,  $r = ce^\phi$ , where, c is a constant.
  - (a) If  $\dot{\phi} = b/r^2$ , where, b is a constant, find the velocity, acceleration and radius of curvature at any position r. Note the radius of curvature  $\rho$ , may be obtained as  $\rho = |\vec{v}|^3 / |\vec{v} \times \vec{a}|$ .
  - (b) Rework part (a) if the speed of the point along the path is constant and equal to V.
- 2) Consider the fly-ball governor shown in the figure. Arms OA and OB are hinged to the shaft at O, however, when the sleeve, S, moves up,  $\theta$  increases and the balls move radially outward and upward. At this instant,  $\theta = 40^\circ$ ;  $\omega = 2$  rad/s;  $\dot{\omega} = 0.4$  rad/s<sup>2</sup>, and the sleeve, S, is moving up at a speed  $v = 2$  m/s which is changing at the rate  $a = -0.1$  m/s<sup>2</sup> (i.e. the speed is decreasing). OA = 0.5m and OC = 0.3m.

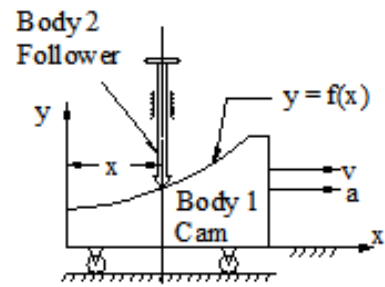
Find the velocity and acceleration of ball B, with respect to ground, at this instant. Hence find the force exerted by the ball, B, on the shaft. The mass of each ball is 0.2 Kg.



Problem 2



Problem 3



Problem 4

- 3) A pin P moves in a fixed parabolic slot whose equation is given by,  $x = cy^2$ , and in a straight horizontal slot as shown. The straight slot translates in the y-direction at a constant acceleration  $a_0$ , starting from rest at  $t=0$ , when the pin is at the origin. Find the position, velocity and acceleration of P at time t.
- 4) Body 1 (cam) moves to the right with velocity v, and acceleration a, as shown. Determine the velocity and acceleration of body 2 (follower).
- 5) A small block of mass,  $m = 0.5$  Kg, slides down a hill whose shape may be approximated by  $y = H \cos(\pi x/L)$ , where  $H = 200$  m and  $L = 800$  m. Its speed at the position shown is 40 m/s. Find the rate of increase of speed in this position if the coefficient of friction between the hill and the block is 0.2

