Tutorial # 1: Particle Kinematics

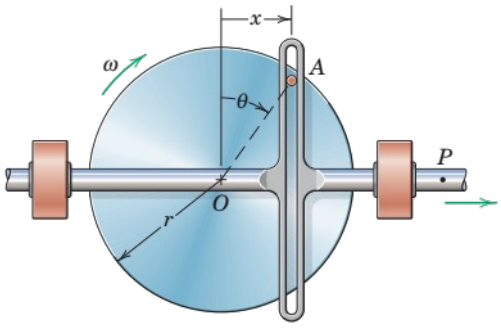

Figure 1

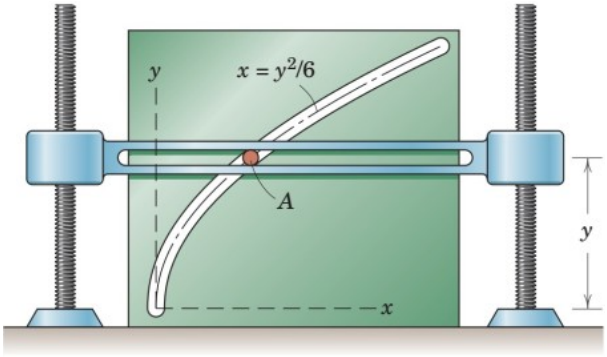

Figure 2

Q1. A Scotch-Yoke mechanism (See Figure 1) is used to convert rotary motion into reciprocating motion. As the disk rotates at the constant angular rate ω, a pin A slides in a vertical slot causing the slotted member to displace horizontally. Determine the horizontal displacement x of the slotted member relative to the fixed disk centre O. Further determine the velocity, acceleration of a point P on the output shaft of the mechanism as a function of time. What is the maximum velocity and acceleration of the point P.

Q2. For a certain interval of motion the pin A is forced to move in the fixed parabolic slot by the horizontal slotted arm which is elevated in the y-direction (See Figure 2) at the constant rate of 30 mm/sec. All measurements are in mm and seconds. Calculate the velocity v and acceleration a of pin A when x = 60 mm.

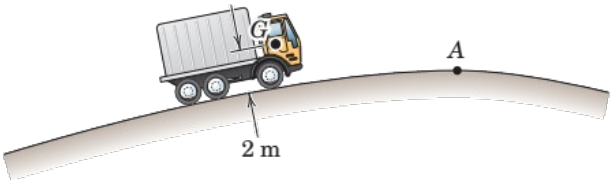

Figure 3

Q3. The driver of the truck has an acceleration of $0.4g$ as the truck passes over the top A of the hump in the road at constant speed (See Figure 3). The radius of curvature of the road at the top of the hump is 98 m, and the center of mass G of the driver (considered a particle) is 2 m above the road. Calculate the speed v of the truck.

Q4. A train enters a curved horizontal section of track at a speed of 100 km/h and slows down with constant deceleration to 50 km/h in 12 seconds. An accelerometer mounted inside the train records a horizontal acceleration of 2 m/s^2 when the train is 6 seconds into the curve. Calculate the radius of curvature ρ of the track for this instant.

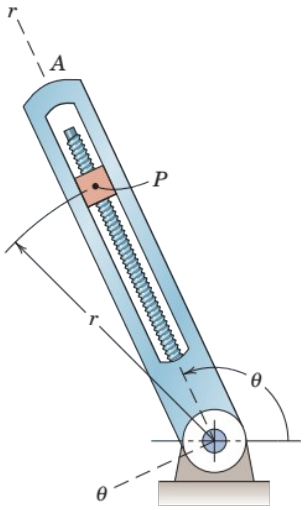

Figure 4

Q5. Motion of the sliding block *P* in the rotating radial slot is controlled by the power screw as shown in Figure 4. For the instant represented, $d\theta/dt = 0.1$ rad/s, $d^2\theta/dt^2 = -0.04$ rad/s^2, and $r = 300$ mm. Also, the screw turns at a constant speed giving $dr/dt = 40$ mm/s. For this instant, determine the magnitudes of the velocity *v* and acceleration *a* of *P*.