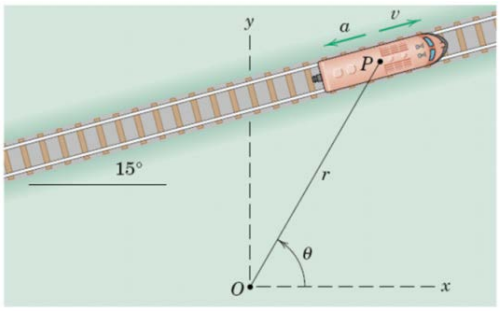
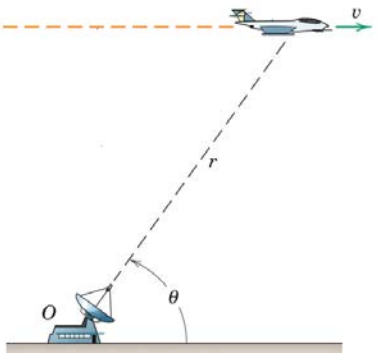
Homework No. 7 – *Due Friday, 9/18*

(1) A locomotive is traveling on the straight track as shown. At the instant when $r = 400$ m and $\theta = 75^\circ$, the tracking device records $\dot{r} = 20$ m/s and $\ddot{\theta} = 0.02$ rad/s^2. Determine (a) the magnitudes of the velocity and acceleration of the locomotive, (b) $\dot{\theta}$ and $\ddot{r}$ at this instant.



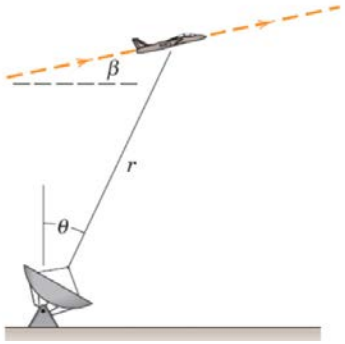
Ans: $v = 40$ m/s, $a = 5.24$ m/s^2, $\dot{\theta} = -0.0866$ rad/s, $\ddot{r} = 0.381$ m/s^2

(2) The motion of a jet plane flying horizontally is being tracked by the radar located at O as shown. At the instant when $r = 2500$ m and $\theta = 60°$, the tracking device records the values $\dot{r} = 100$ m/s and $\ddot{\theta} = 0.002$ rad/s^2. Determine the value of $\ddot{r}$ at this position.



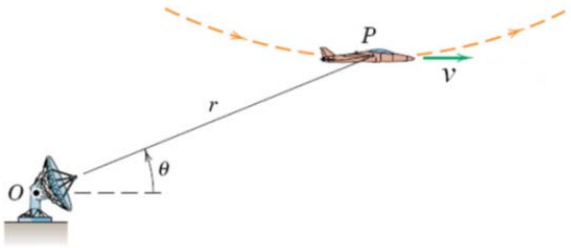
Ans: 17.11 m/s^2

(3) The ground radar is tracking the motion of an airplane that is flying in a straight line gaining altitude at a climb angle of $\beta = 30°$ shown. At a certain instant the recorded values indicate $r = 1500$ ft, $\theta = \tan^{-1}(3/4)$, $\dot{r} = 360$ ft/sec, and $\ddot{\theta} = -0.055$ rad/sec^2. Determine the value $\ddot{r}$ for this position.



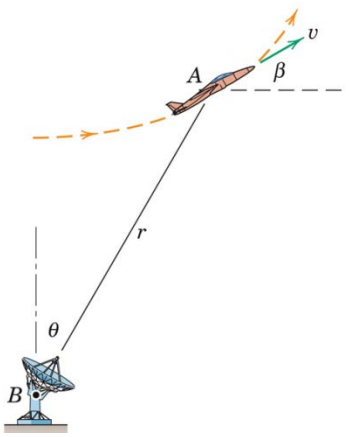
Ans: $\ddot{r} = -4.57$ ft/sec^2

(4) The airplane dives down along a curved trajectory and at the bottom of the vertical loop it has a horizontal velocity v shown. At this lowest point, the radius of curvature of the loop is $\rho = 1600$ m and the speed of the plane is increasing at a rate of 5 m/s^2. If the radar tracking indicates $r = 500$ m, $\theta = 60^\circ$, and $\dot{r} = 100$ m/s, determine (a) the speed v and (b) $\ddot{r}$ and $\ddot{\theta}$ for this instant.



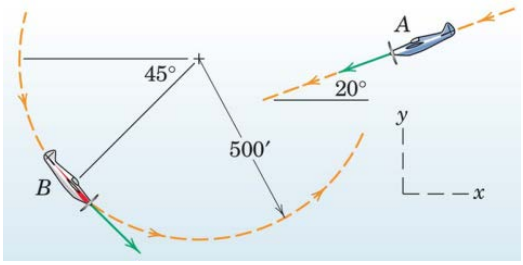
Ans: (a) $v = 200$ m/s (b) $\ddot{r} = 84.2$ m/s^2, $\ddot{\theta} = 0.1549$ rad/s^2

(5) During a portion of the airplane's vertical loop the angle of the velocity is $\beta = 25°$ at point A and the radar tracking records values of $r = 1000$ m, $\theta = 35^{\circ}$, $\dot{r} = 150$ m/s, and $\ddot{r} = 25$ m/s^2. If the radius of curvature at A is 600 m, determine $\ddot{\theta}$ and the tangential acceleration of the plane.



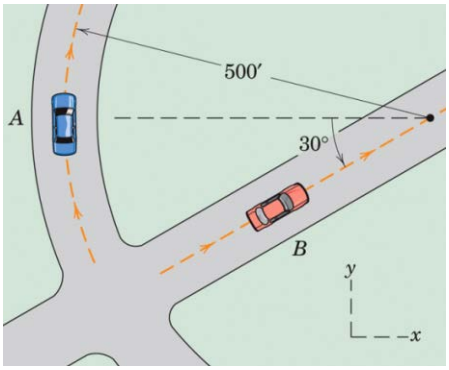
Ans: $\ddot{\theta} = -0.0736$ rad/s^2, $a_t = -8.66$ m/s^2

(6) At an air show plane A flies along the indicated straight path while plane B executes a vertical loop shown. At the position under consideration plane A has a speed of 265 mi/hr that is increasing at a rate of 4 mi/hr/sec and the speed of plane B is 150 mi/hr that remains constant. Determine the velocity and acceleration of plane B with respect to plane A for this instant.



Ans: $\vec{v}_{B/A} = 355\hat{i} - 15.43\hat{j}$ mi/hr, $\vec{a}_{B/A} = 74.0\hat{i} + 70.5\hat{j}$ ft/sec^2

(7) For the instant represented car A is rounding the circular curve with a speed of 40 ft/sec and is speeding up at the rate of 2 ft/sec^2, while car B on the straightaway is speeding up at the rate of 5 ft/sec^2. Determine the relative acceleration of car A with respect to an observer in car B.



Ans: $-1.130\hat{i} - 0.5\hat{j}$ ft/sec^2