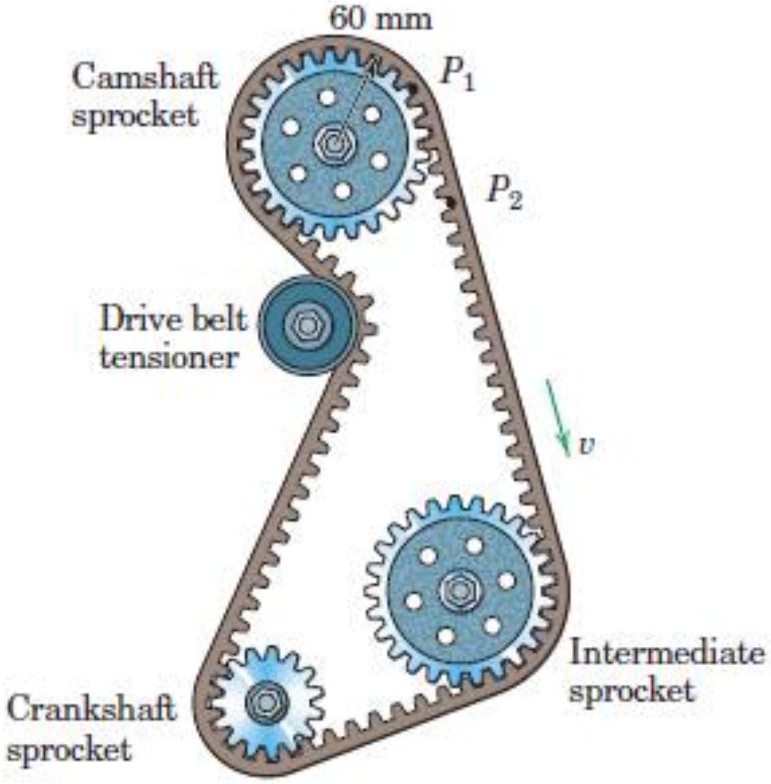
ME 206 – DYNAMICS – SPRING 2017
STUDY PROBLEMS-2 (PARTICLE KINEMATICS, SECTION 2.5)

PROBLEM 2/119

The design of a camshaft-drive system of a four-cylinder automobile engine is shown. As the engine is revved up, the belt speed v changes uniformly from 3 m/s to 6 m/s over a two-second interval. Calculate the magnitudes of the accelerations of points P_1 and P_2 halfway through this time interval.



2/119 $a_t = \frac{v_f - v_i}{\Delta t} = \frac{6-3}{2} = 1.5 \text{ m/s}^2$

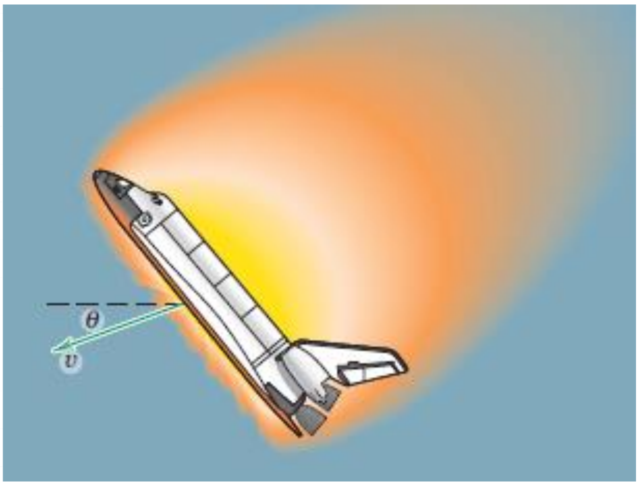
Halfway through time interval, $v = 4.5$ m/s

$a_{P_1} = \sqrt{a_t^2 + a_n^2} = \sqrt{1.5^2 + \left(\frac{4.5^2}{0.060}\right)^2}$

$= \underline{338 \text{ m/s}^2}$ (34.4g!)

$a_{P_2} = a_t = \underline{1.5 \text{ m/s}^2}$

PROBLEM 2/121



At a certain point in the reentry of the space shuttle into the earth's atmosphere, the total acceleration of the shuttle may be represented by two components. One component is the gravitational acceleration $g = 9.66\ \text{m/s}^2$ at this altitude. The second component equals $12.90\ \text{m/s}^2$ due to atmospheric resistance and is directed opposite to the velocity. The shuttle is at an altitude of 48.2 km and has reduced its orbital velocity of 28 300 km/h to 15 450 km/h in the direction $\theta = 1.50°$. For this instant, calculate the radius of curvature ρ of the path and the rate $\dot{v}$ at which the speed is changing.

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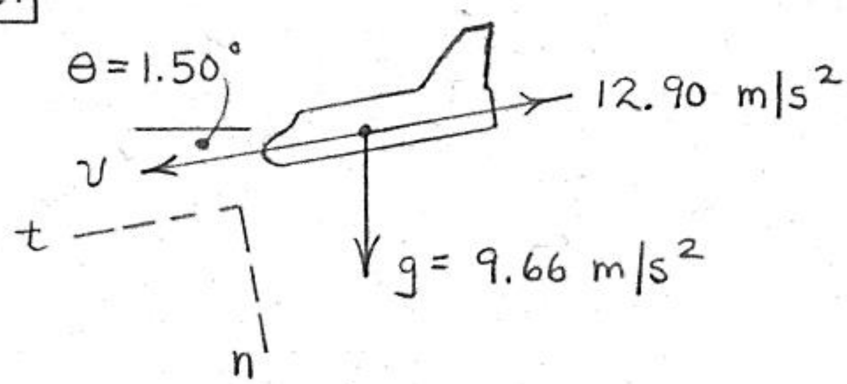


$$\dot{v} = a_t = 9.66 \sin 1.50° - 12.90 = \underline{-12.65\ \text{m/s}^2}$$

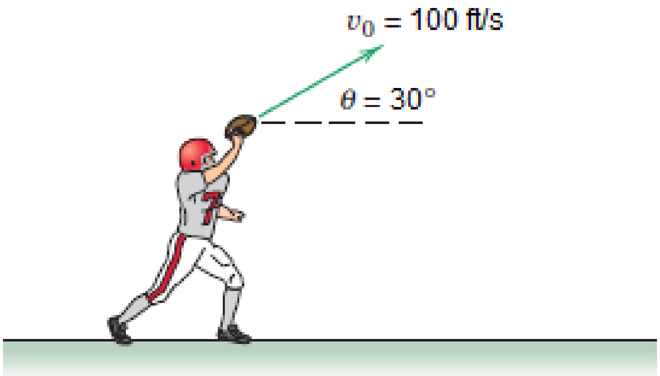
$$a_n = g \cos\theta = 9.66 \cos 1.5° = 9.657\ \text{m/s}^2$$

$$a_n = \frac{v^2}{\rho} \Rightarrow \rho = \frac{v^2}{a_n} = \frac{(15\,450/3.6)^2}{9.657}$$

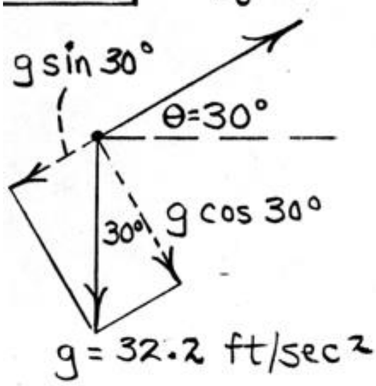
$$\underline{\rho = 1907\ \text{km}}$$

PROBLEM 2/116

A football player releases a ball with the initial conditions shown in the figure. Determine the radius of curvature of the trajectory (*a*) just after release and (*b*) at the apex. For each case, compute the time rate of change of the speed.



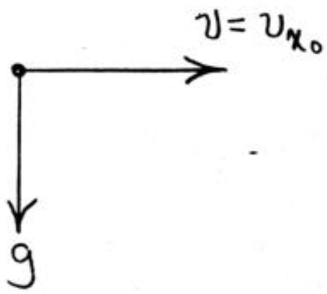
2/116 $\quad v_0 = 100$ ft/sec



(a) $a_n = g\cos 30° = \dfrac{v^2}{\rho}$

$\rho = \dfrac{100^2}{g\cos 30°} = \underline{359 \text{ ft}}$

$\dot{v} = -g\sin 30° = \underline{-16.1 \text{ ft/sec}^2}$



(b) $a_n = g = \dfrac{v^2}{\rho}$

$\rho = \dfrac{(100\cos 30°)^2}{32.2} = \underline{233 \text{ ft}}$

$\underline{\dot{v} = 0}$