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••53 An airplane is flying in a horizontal circle at a speed of 480 km/h (Fig. 6-42). If its wings are tilted at angle $\theta = 40°$ to the horizontal, what is the radius of the circle in which the plane is flying? Assume that the required force is provided entirely by an "aerodynamic lift" that is perpendicular to the wing surface. SSM WWW

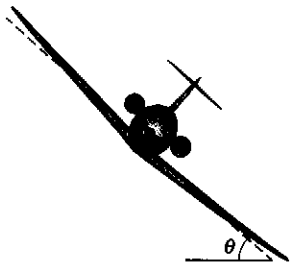
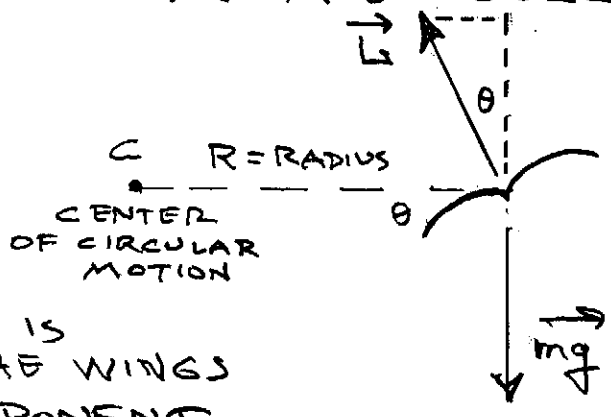


FIG. 6-42 Problem 53.

THE PROBLEM WOULD BE THE SAME FOR ANY OBJECT IN FLIGHT, FOR EXAMPLE A BIRD LIKE A SEAGULL

SEAGULL IN LEVEL FLIGHT FLYING INTO THE PAGE



THE LIFT FORCE WHICH IS PERPENDICULAR TO THE WINGS HAS A VERTICAL COMPONENT

TO MAINTAIN LEVEL OR HORIZONTAL FLIGHT:

$$\vec{F}^{net}_{on\,gull} = m_g \vec{a}_g \Rightarrow F_v^{net} = ma_v = 0 \Rightarrow L\cos\theta - mg = 0$$

$$\Rightarrow L = mg/\cos\theta \;\&\; L\cos\theta = mg$$

AND $\vec{L}$ HAS A HORIZONTAL OR RADIAL COMPONENT TO SUPPLY THE CENTRIPETAL ACCELERATION.

$$\vec{F}^{net}_{gull} = m_g \vec{a}_g \Rightarrow F_r^{net} = m_g a_c \Rightarrow L\sin\theta = m\frac{v^2}{R}$$

Dividing the Components of the Eqn of Motion:

$$\frac{L\sin\theta}{L\cos\theta} = \frac{mv^2/R}{mg} \Rightarrow \tan\theta = \frac{v^2}{gR}$$

$$\Rightarrow R = \frac{v^2}{g\tan\theta}$$

PLANE: $R = \left[480\,\frac{km}{hr}\left(\frac{1hr}{3600s}\right)\left(\frac{1000m}{1km}\right)\right]^2 / (9.80\tan 40°)$

$$= 2.16\times10^3\,m = 2.2\,km$$

IN THIS PROBLEM THE DRAG (opposite to $\vec{v}$) IS BALANCED BY A THRUST (in direction of $\vec{v}$) IN ORDER TO MAINTAIN CONSTANT SPEED.