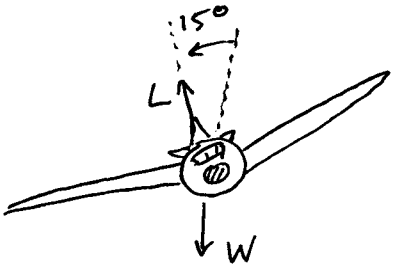
AE 252 (Spring 2007)

2/6/07

Bretl

Example: newton's laws (text problem 14.80)



Airplane making a turn at constant altitude and at constant speed.

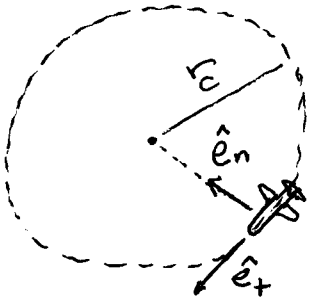
weight $W = 200{,}000$ lb

speed $V = 600$ ft/s

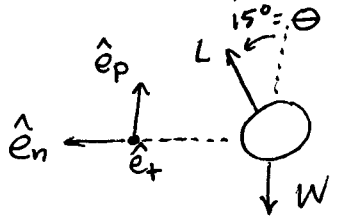
bank angle $\Theta = 15°$

(a) Find lift force L.

(b) Find radius of curvature of airplane's path.



① Free-body diagram.



② Coordinate axes.

Want to know something about radius of curvature
→ path coordinates!

③ Acceleration.

From problem statement, $a_t = a_p = 0$. $\Rightarrow \vec{a} = \frac{V^2}{r_c} \hat{e}_n$

④ Forces. (Don't have to consider $\hat{e}_t$ direction!)

$$\Sigma \vec{F} = (L\cos\Theta - W)\,\hat{e}_p + L\sin\Theta\,\hat{e}_n$$

(5) Newton's law.

$$\Sigma \vec{F} = m\vec{a} \quad \Rightarrow \quad L\cos\theta - W = 0$$

$$L\sin\theta = \frac{mv^2}{r_c}$$

(6) (Don't need to derive equations of motion.)

(7) Solve for quantities of interest.

Lift force: $L\cos\theta = W \Rightarrow \boxed{L = \frac{W}{\cos\theta} = 207{,}000 \text{ lb}}$

Radius of curvature: $\frac{mv^2}{r_c} = L\sin\theta = W\tan\theta$ (plug in for L)

Also note $mg = W \Rightarrow m = \frac{W}{g}$.

$$\Rightarrow \quad \frac{Wv^2}{g r_c} = W\tan\theta$$

$$\Rightarrow \quad \boxed{r_c = \frac{v^2}{g\tan\theta} = 41{,}700 \text{ ft}}$$