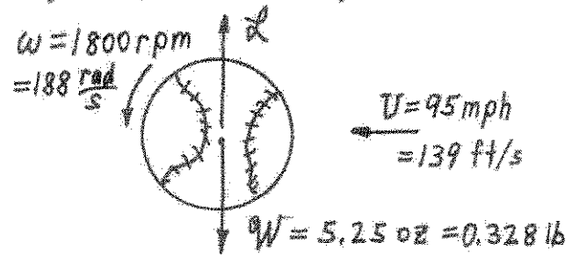
9.120

9.120 For many years, hitters have claimed that some baseball pitchers have the ability to actually throw a rising **fastball**. Assuming that a top major leaguer pitcher can throw a 95-mph pitch and impart a 1800-rpm spin to the ball, is it possible for the ball to actually rise? Assume the baseball diameter is 2.9 in. and its weight is 5.25 oz.

If the lift produced on the spinning ball is greater than its weight the ball will rise.



$\mathcal{L} = C_L \frac{1}{2}\rho V^2 A$

where C_L is a function of $\frac{\omega D}{2V}$ as shown in Fig. 9.39.

Thus, with

$$\frac{\omega D}{2V} = \frac{(188 \frac{rad}{s})(\frac{2.9}{12} ft)}{2(139 ft/s)} = 0.163$$

$C_L \approx 0.04$

Hence, for the given conditions

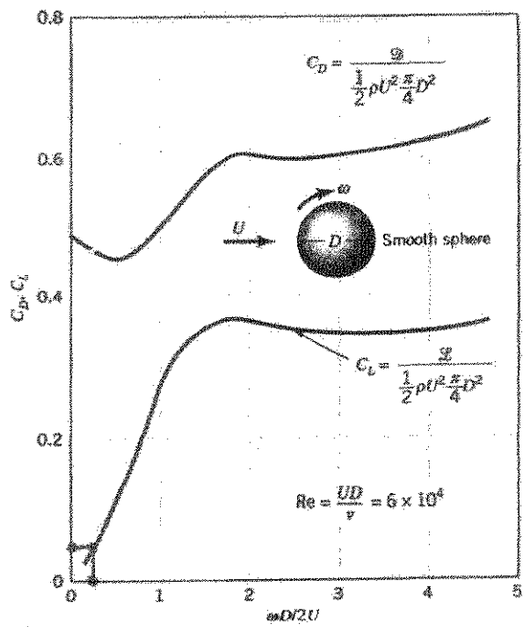
$$\mathcal{L} = 0.04\left(\tfrac{1}{2}\right)\left(0.00238 \tfrac{slugs}{ft^3}\right)\left(139 \tfrac{ft}{s}\right)^2 \times \frac{\pi}{4}\left(\frac{2.9}{12} ft\right)^2 = 0.0422 \text{ lb}$$

so that

$\mathcal{L} = 0.0422 \text{ lb} < W = 0.328 \text{ lb}$

The ball will not rise.

Note: The above result is based on smooth-sphere data. The results for a baseball (with its rough surface containing seams) will probably give a somewhat larger lift because for a given angular velocity it can "drag" more air along as it spins.



■ FIGURE 9.39 Lift and drag coefficients for a spinning smooth sphere (Ref. 23).