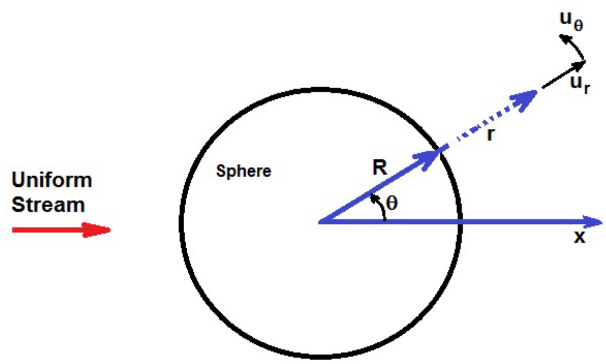
Solution of Problem 122B:

The potential flow around a sphere is generated by the superposition of a point doublet whose potential flow has the form $B\cos\theta/r^2$ and a uniform stream, Ux: Therefore



$$\phi \quad = \quad Ux + \frac{B\cos\theta}{r^2} \quad = \quad \cos\theta\left\{Ur + \frac{B}{r^2}\right\} \tag{1}$$

It follows that the velocities in the r and θ directions, u_r and u_θ, are

$$u_r \quad = \quad \frac{\partial\phi}{\partial r} \quad = \quad \cos\theta\left\{U - \frac{2B}{r^3}\right\} \tag{2}$$

$$u_\theta \quad = \quad \frac{1}{r}\frac{\partial\phi}{\partial\theta} \quad = \quad -\frac{\sin\theta}{r}\left\{Ur + \frac{B}{r^2}\right\} \tag{3}$$

But on the surface of the sphere, $r = R$, we must have $u_r = 0$. Therefore

$$U - \frac{2B}{R^3} \quad = \quad 0 \quad \text{and therefore} \quad B \quad = \quad \frac{UR^3}{2} \tag{4}$$

Hence

$$u_\theta \quad = \quad \frac{\sin\theta}{r}\left\{Ur + \frac{UR^3}{2r}\right\} \tag{5}$$

and on the surface

$$\{u_\theta\}_{r=R} \quad = \quad -\frac{\sin\theta}{R}\left\{UR + \frac{UR}{2}\right\} \quad = \quad -\frac{3U}{2}\sin\theta \tag{6}$$

and therefore the ratio of the maximum velocity on the surface to the uniform stream velocity is 3/2.