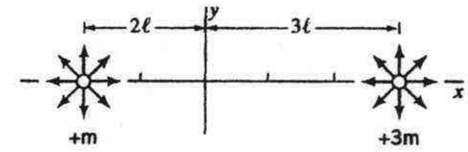
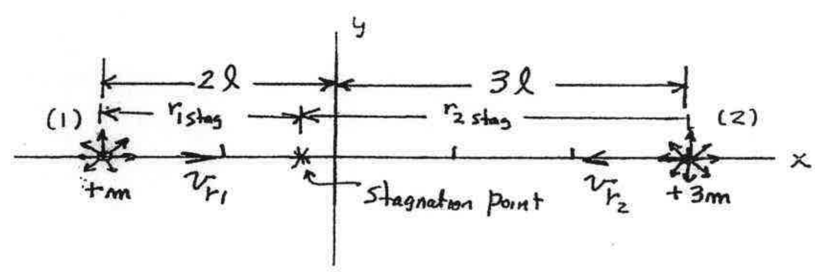
6.34

6.34 Two sources, one of strength m and the other with strength $3m$ are located on the x axis as shown in Fig. P6.34. Determine the location of the stagnation point in the flow produced by these sources.



■ **FIGURE P6.34**

Since the flow from each source is in the radial direction, it is only along the x-axis that the two radial components can cancel and create a stagnation point.



For source (1)

$$v_{r_1} = \frac{m}{2\pi r_1}$$

and for source (2)

$$v_{r_2} = \frac{3m}{2\pi r_2}$$

The stagnation point occurs where $v_{r_1} = v_{r_2}$ so that

$$\frac{m}{2\pi r_{1\,stag}} = \frac{3m}{2\pi r_{2\,stag}}$$

and

$$\frac{r_{2\,stag}}{r_{1\,stag}} = 3$$

Also,

$$r_{1\,stag} + r_{2\,stag} = 2\ell + 3\ell = 5\ell$$

so that

$$r_{1\,stag} + 3r_{1\,stag} = 5\ell$$

$$r_{1\,stag} = \frac{5}{4}\ell$$

Thus,

$$x_{stag} = -\left(2\ell - \frac{5}{4}\ell\right) = \underline{\underline{-0.75\ell}}$$

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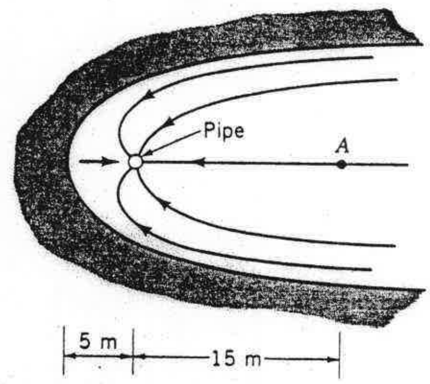
6.46

6.46 One end of a pond has a shoreline that resembles a half-body as shown in Fig. P6.46. A vertical porous pipe is located near the end of the pond so that water can be pumped out. When water is pumped at the rate of $0.06\ m^3/s$ through a 3-m-long pipe, what will be the velocity at point A? *Hint:* Consider the flow *inside* a half-body.



■ FIGURE P6.46

For a half-body,

$$\psi = U r \sin\theta + \frac{m}{2\pi}\theta \qquad (Eq.\ 6.97)$$

so that

$$v_\theta = -\frac{\partial\psi}{\partial r} = U \sin\theta$$

and

$$v_r = \frac{1}{r}\frac{\partial\psi}{\partial\theta} = U\cos\theta + \frac{m}{2\pi r}$$

Thus, at point A, $\theta = 0$, $r = 15m$ and

$$v_\theta = 0$$

$$v_r = V_A = U + \frac{m}{2\pi(15)} \qquad (1)$$

For a flowrate of $0.06\frac{m^3}{s}$ in a 3-m long pipe, the source strength is $\frac{0.06}{3}\frac{m^2}{s}$. Since

$$b = \frac{m}{2\pi U} \qquad (Eq.\ 6.99)$$

then with $b = 5m$

$$U = \frac{m}{2\pi b} = \frac{\left(\frac{0.06}{3}\frac{m^2}{s}\right)}{2\pi(5m)} = 6.37 \times 10^{-4}\frac{m}{s}$$

From Eq. (1)

$$V_A = 6.37\times10^{-4}\frac{m}{s} + \frac{\left(\frac{0.06}{3}\frac{m^2}{s}\right)}{2\pi\ (15m)}$$

$$= \underline{\underline{8.49\times10^{-4}\frac{m}{s}}}$$

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