

## Problem 2.90

[Difficulty: 2]

**2.90** A seaplane is flying at 100 mph through air at 45°F. At what distance from the leading edge of the underside of the fuselage does the boundary layer transition to turbulence? How does this boundary layer transition change as the underside of the fuselage touches the water during landing? Assume the water temperature is also 45°F.

**Given:** Data on seaplane

**Find:** Transition point of boundary layer

**Solution:**

For boundary layer transition, from Section 2-6  $Re_{trans} = 500000$

Then 
$$Re_{trans} = \frac{\rho \cdot V \cdot x_{trans}}{\mu} = \frac{V \cdot x_{trans}}{\nu} \quad \text{so} \quad x_{trans} = \frac{\nu \cdot Re_{trans}}{V}$$

At 45°F = 7.2°C (Fig A.3) 
$$\nu = 0.8 \times 10^{-5} \frac{m^2}{s} \times \frac{10.8 \frac{ft^2}{s}}{1 \frac{m^2}{s}} \quad \nu = 8.64 \times 10^{-5} \frac{ft^2}{s}$$

$$x_{trans} = 8.64 \times 10^{-5} \frac{ft^2}{s} \cdot 500000 \times \frac{1}{100 \cdot mph} \times \frac{60 \cdot mph}{88 \frac{ft}{s}} \quad x_{trans} = 0.295 \cdot ft$$

As the seaplane touches down:

At 45°F = 7.2°C (Fig A.3) 
$$\nu = 1.5 \times 10^{-5} \frac{m^2}{s} \times \frac{10.8 \frac{ft^2}{s}}{1 \frac{m^2}{s}} \quad \nu = 1.62 \times 10^{-4} \frac{ft^2}{s}$$

$$x_{trans} = 1.62 \times 10^{-4} \frac{ft^2}{s} \cdot 500000 \times \frac{1}{100 \cdot mph} \times \frac{60 \cdot mph}{88 \frac{ft}{s}} \quad x_{trans} = 0.552 \cdot ft$$