6.36 The following turbulent-flow velocity data $u(y)$, for air at 75°F and 1 atm near a smooth flat wall, were taken in the University of Rhode Island wind tunnel:

y, in:	0.025	0.035	0.047	0.055	0.065
u, ft/s:	51.2	54.2	56.8	57.6	59.1

Estimate (a) the wall shear stress and (b) the velocity u at $y = 0.22$ in.

(a) $\rho = .0023$ slug/ft^3 $\mu = 3.8 \times 10^{-7}$ slug/ft s

$u/u^+ = \frac{1}{\kappa} \ln \frac{\rho u^* y}{\mu} + B$ $\kappa = .41$ $B = 5$

$u^+ = \sqrt{\tau_w/\rho}$

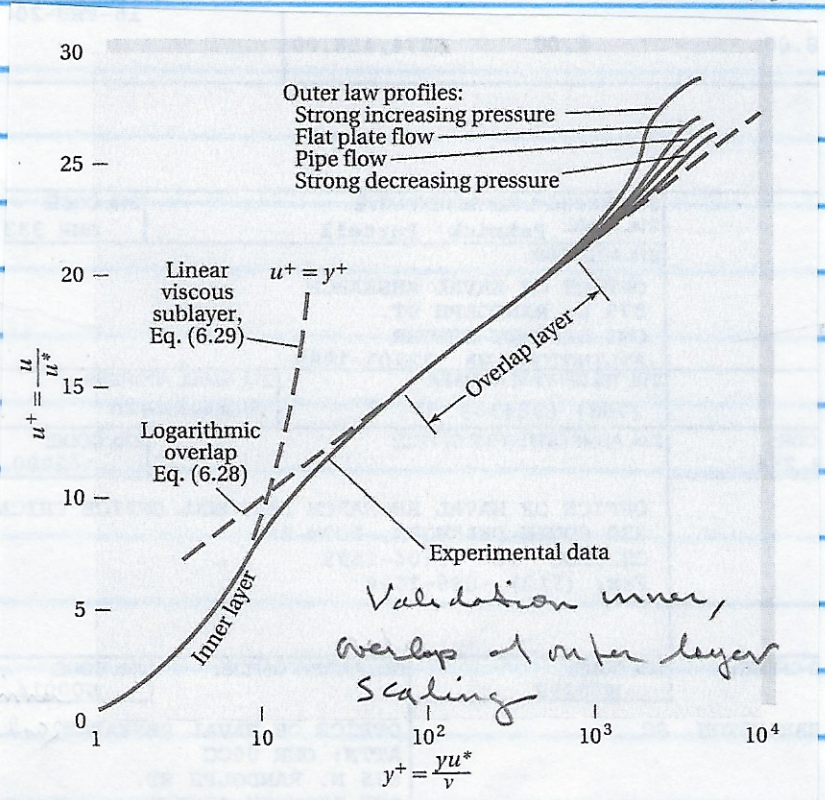
Enter each value of u and y from the data and estimate the friction velocity u*:

y, in:	0.025	0.035	0.047	0.055	0.065
u*, ft/s:	3.58	3.58	3.59	3.56	3.56
yu*/ν (approx):	45	63	85	99	117

$u^*_{ave} = 3.57$ ft/s $\pm 1\%$ $\tau_{w\,ave} = \rho u_*^2 = .0293 \frac{lbf}{ft^2}$

(b) $u(y=.22'')$ $\frac{\rho u^* y}{\mu} = 396$ OK $u = u^* \left[\frac{1}{.41} \ln(396) + 5\right]$

$= 70$ ft/s



Validation inner, overlap & outer layer scaling

Outer layer

$u^+ = \frac{1}{\kappa} \ln y^+ + B + \frac{\Pi}{\kappa} W(x/\delta)$

$\Pi = \Pi(\beta)$

$\beta = \frac{\delta^+}{\tau_w} \frac{dp}{dx}$

Sublayer $y^+ \leq 5$

$u^+ = y^+$

Buffer layer

$5 \leq y^+ \leq 30$

overlap layer = log law $y^+ > 30$ & < value depends Re & β