

$$4) a) R_x = \frac{U x \rho}{\mu}$$

(3)

$$x = \frac{R_x \mu}{U \rho} = \frac{5 \times 10^5 \times 1.79 \times 10^{-5}}{\left(\frac{144 \times 1000}{3600} \right) \times 1.225} = 0.1827 \text{ m}$$

$$b) i) \delta = x \sqrt{\frac{30}{R}} = 0.1827 \times \sqrt{\frac{30}{5 \times 10^5}} = 1.42 \text{ mm}$$

$$ii) \delta = \frac{0.38}{R^{0.2}} x = \frac{0.38 \times 150}{\left(\frac{40 \times 150 \times 1.225}{1.79 \times 10^{-5}} \right)^{0.2}}$$

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$$= 1.079 \text{ m}$$

$$c) \eta = \frac{3}{2} \mu \frac{U}{\delta}$$

$$= \frac{3}{2} \times 1.79 \times 10^{-5} \times \frac{40}{1.42 \times 10^{-3}}$$

$$= 0.756$$

$$d) \text{ Drag} = 8.5 \int_0^{150} T_0 dx = 8.5 \int_0^{150} \frac{3}{2} \mu \frac{U}{\delta} dx$$

$$= 12.75 \mu U \left(\int_0^{0.1827} \frac{U \rho}{\sqrt{30 R x}} dx + \int_{0.1827}^{150} 2.63 \left(\frac{U \rho}{40 x} \right)^{1/5} dx \right)$$

$$= 12.75 \mu U \left[2 \sqrt{\frac{U \rho x}{30}} \right]_0^{0.1827} + 13.15 \left(\frac{U \rho x}{40} \right)^{1/5} \Big|_{0.1827}^{150}$$