$\frac{12}{20}$

QUIZ 7 – ME 322 (Fall '03) **Name:** Bryan Trilli 12/9/03

1. A 38.1 mm diameter, 0.0245N table tennis ball is released from the bottom of a swimming pool. Calculate the velocity at which it rises to the surface. Assume it has reached terminal velocity. 10

$r = .01905\,m$ $W = .0245\,N$ $W = D + F_B = 0$ $\nu_{H_2O} = 1.12 \times 10^{-6}\,m^2/s$

$F_B = \gamma_w \frac{4}{3}\pi r^3$

$D = \frac{1}{2}\rho u^2 C_D A$ $Re = \frac{\rho V D}{\mu} = \frac{VD}{\nu} = \frac{(1000)(.0381)}{1.12 \times 10^{-6}} =$

$u^2 = \frac{2D}{\rho C_D A}$ $D = W - F_B =$ $Re = 34,017,857$

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$\frac{kg}{m^3} \cdot \frac{m^2}{s^2} \cdot m^2 = \frac{kg\,m}{s^2} = F$

2. The United Nations Building in New York is approximately 87.5m wide and 154m tall. If the drag coefficient is 1.3 determine the drag on this building if
   a. the wind speed is a uniform 20m/s. 3
   b. the typical urban velocity profile near the building is $u=Cy^{0.4}$, and the wind speed is halfway up the building is 20m/s. 7

$C_D = 1.3$ $A = 13475\,m^2$ $\rho_{Air} = 1.23\,kg/m^3$ $u = 20\,m/s$

a. $D = \frac{1}{2}\rho u^2 C_D A = \frac{1}{2}(1.23)(20)^2(1.3)(13475) = \underline{4,309,305\,N}$

b. $D = \frac{1}{2}\rho C_D A \int_0^{154} (Cy^{0.4})^2\,dy = \frac{1}{2}\rho C_D A C \int y^{.16}\,dy = \frac{1}{2}\rho C_D A C(297.222 - .8621)$

$\int y^{\frac{4}{25}}\,dy = \frac{25}{29} y^{\frac{29}{25}} = .8621\,y^{1.16}\Big|_0^{154}$ $C = \frac{u}{y^{.4}} = \frac{20}{77^{.4}} = 22.20$

$D = \frac{1}{2}(1.23)(1.3)(13475)(296.3604)C = 3192768\,C = \cancel{70,892,635\,N}$

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