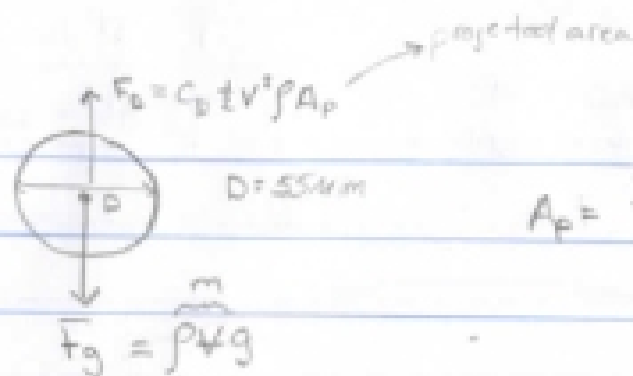


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Example 7.5

No friction
 $v(t) = \frac{1}{2}at^2$ 

$T_{\infty} = 25^\circ\text{C}$

$v_{\text{air}} = 15.9 \times 10^{-6} \frac{\text{m}}{\text{s}}$

$\rho_{\text{air}} \approx 0$

$\mu_{\text{air}} = 0.002 \text{ Pa}\cdot\text{s}$

$$F_D = F_g \rightarrow C_D \frac{1}{2} v^2 \rho \frac{\pi D^2}{4} = \rho \frac{\pi D^3}{6} g$$

$$Re = \frac{vD}{\nu} = \frac{(15.9 \times 10^{-6} \text{ m/s}) (55 \times 10^{-6} \text{ m})}{15.9 \times 10^{-6} \frac{\text{m}^2}{\text{s}}} = 0.3 \quad \text{so } C_D = \frac{24}{ReD} = \frac{24\nu}{vD}$$

$$\rho \frac{\pi D^3}{6} g = \frac{24}{vD} \frac{1}{2} v^2 \rho \frac{\pi D^3}{6} \frac{1}{4} \rightarrow \rho D g = \frac{18\nu}{D} v \rho$$

$$v = 0.19 \frac{\text{m}}{\text{s}} \quad Re = 0.65$$

How much time is needed to get from 200°C to 50°C

$$\dot{E}_{\text{out}} = \dot{E}_{\text{in}} - \dot{E}_{\text{loss}} + \dot{E}_{\text{gen}}$$

$$mC \frac{dT_s}{dt} = -hA_s (T_s - T_{\infty})$$

$$mC \frac{d\theta}{dt} = -hA_s \theta$$

$$\overline{Nu}_D = 2 + 0.6 Re_D^{1/2} Pr^{1/3} = 2 + 0.6 (0.65)^{1/2} (7)^{1/3} = 2.43$$

$$\overline{h} = \frac{\overline{Nu}_D k}{D} \rightarrow \frac{(2.43)(0.033 \frac{\text{W}}{\text{m}\cdot\text{K}})}{(55 \times 10^{-6} \text{ m})} = \boxed{1162 \frac{\text{W}}{\text{m}^2\cdot\text{K}}}$$

$$0 \frac{m}{s} < V < 80 \frac{m}{s}$$

$$\nu = 14 \times 10^{-6} \frac{m^2}{s}$$

$$V_{max} = 78 \frac{m}{s}$$



w/o dimples

$$Re = \frac{Vd}{\nu} = \frac{80(.043m)}{14 \times 10^{-6} \frac{m^2}{s}} = 245 \times 10^5$$

Assume $C_D \approx 0.1$ Find Force F_D

$$C_D \frac{1}{2} V^2 \rho \frac{\pi D^2}{4} = (.1) \frac{1}{2} (80 \frac{m}{s})^2 (1.1 \frac{kg}{m^3}) \frac{\pi (.043m)^2}{4} = 0.511 N$$