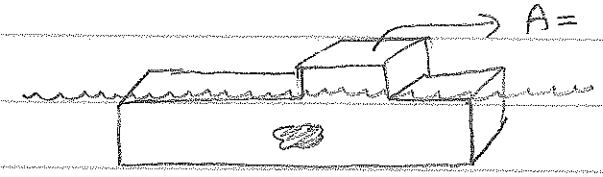
HRW

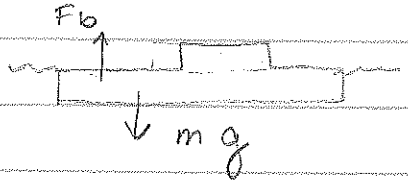
14-40) Alligator swallowing stones



Simplified model of alligator

Swallows stones w/ total mass 1.0% of body weight

Before swallowing:



$$F_b = mg$$

Archimedes: $F_b = \rho_w V_{subm} g$

$$V_{subm} = \frac{mg}{\rho_w g} = \frac{m}{\rho_w}$$

Mass of alligator w/ stone = $1.01m = m_2$

After swallowing: $V_{subm_2} = \frac{m_2}{\rho_w} = \frac{1.01m}{\rho_w}$

$$\Rightarrow V_{subm_2} = 1.01 V_{subm}$$

Extra volume submerged $V = V_{subm_2} - V_{subm} = 0.01 V_{subm}$

$= A \cdot d$

$\Rightarrow$ Alligator sinks $d = \frac{0.01 V_{subm}}{A} = \frac{0.01 m}{\rho_w A}$

$$d = \frac{0.01(130)\,kg}{(998)\,kg/m^3 (0.20\,m^2)} = 6.5\,mm$$