STAEDTLER® No. 937 811E Engineer's Computation Pad

••38 *Lurking alligators.* An alligator waits for prey by floating with only the top of its head exposed, so that the prey cannot easily see it. One way it can adjust the extent of sinking is by controlling the size of its lungs. Another way may be by swallowing stones (*gastrolithes*) that then reside in the stomach. Figure 14-41 shows a highly simplified model (a "rhombohedron gater") of mass 130 kg that roams with its head partially exposed. The top head surface has area 0.20 m^2. If the alligator were to swallow stones with a total mass of 1.0% of its body mass (a typical amount), how far would it sink?



FIG. 14-41 Problem 38.

IT WOULD SINK AN AMOUNT IN ACCORD WITH ARCHIMEDE'S PRINCIPLE &

$$\vec{F}_{\text{net on gator}} = m_{\text{gator}}\vec{g} + \vec{B} \equiv 0$$

BEFORE EATING STONES: $m_{\text{gator}} g = m^{\text{no stones}}_{\text{displaced fluid}} g$

$$\Rightarrow m_{\text{gator}} = \rho_f V^{\text{no stones}}_{\text{Displaced fluid}}$$

AFTER EATING STONES: $(m_{\text{gator}} + m_s) g = m^{\text{with stones}}_{\text{displaced fluid}} g$

$$\Rightarrow m_{\text{gator}} + m_{\text{stones}} = \rho_f V^{\text{with stones}}_{\text{Displaced fluid}}$$

SUBTRACT EQUATIONS:

$$\Rightarrow m_{\text{stones}} = \rho_f \left(V^{\text{WITH STONES}}_{\text{Displaced fluid}} - V^{\text{no stones}}_{\text{Displaced fluid}} \right)$$

$$= \rho_f \left(\Delta V = h A^{\text{exposed}}_{\text{cross section}} \right)$$

(h ↑ zhoint sunk)

$$\Rightarrow h = m_{\text{stones}} / \rho_f A_{\text{cross}}$$

$$= \frac{m_{\text{gator}} / 100}{\rho_{\text{water}} (0.2 = 1/5)\, m^2}$$

$$= \frac{1.3\,(5)}{1000} = 6.5 \times 10^{-3}\ m$$

$$= 6.5\ mm$$