1. A 120lb person takes a six-foot-long Styrofoam “noodle” shaped like a large pencil into a swimming pool. What diameter does the noodle need to be to float the person so that her head is completely above the water? Assume that the person’s head accounts for 15% of the person’s total weight. Also, assume that the unit weight of the human body = the unit weight of water = 62.4 pcf and the unit weight of Styrofoam = 0.75 pcf. Hint: ignore the part of the person’s body that is underwater.

\[ B = W \]

\[ W = W_{\text{head}} + W_{\text{noodle}} \]

\[ W_{\text{head}} = 0.15 (120\text{lb}) = 18.0\text{lb} \]

\[ W_{\text{noodle}} = (V_{\text{noodle}})(\text{unit wt}_{\text{noodle}}) \]

\[ V_{\text{noodle}} = \pi r^2 L = \pi r^2 (6\text{ft}) \]

\[ V_{\text{noodle}}(\text{unit wt}_{\text{water}}) = 18.0\text{lb} + V_{\text{noodle}}(\text{unit wt}_{\text{noodle}}) \]

\[ V_{\text{noodle}}(\text{unit wt}_{\text{water}} - 0.75\text{lb/ft}^3) = 18\text{lb}, \quad V_{\text{noodle}} = 0.292\text{ ft}^3 \]

\[ V_{\text{noodle}} = \pi r^2 (6\text{ft}), \quad 0.292\text{ ft}^3 = \pi r^2 (6\text{ft}), \quad r = 0.1245\text{ ft} = 1.49'' \]

**Diameter of noodle = 3.0”**
2a. A 160 lb college student wants to lift the left side of his car so that he can place blocks beneath the wheels. If the car weighs 2900 lb and his lever is 10 ft long, where should he place the fulcrum?

\[ W_1 L_1 = W_2 L_2, \]

\[ W_1 = \frac{1}{2} 2900 \text{ lb} = 1450 \text{ lb}, \]

\[ W_2 = 160 \text{ lb} \]

\[ L_1 + L_2 = 10 \text{ ft}, \quad L_2 = 10 \text{ ft} - L_1 \]

\[ 1450 \text{ lb} L_1 = 160 \text{ lb} (10 \text{ ft} - L_1), \]

\[ L_1(1450 \text{ lb} + 160 \text{ lb}) = 160 \text{ lb} (10 \text{ ft}), \quad L_1 = 0.994 \text{ ft} \approx 1 \text{ ft} \]

\[ L_1 = 1 \text{ ft}, \quad L_2 = 9 \text{ ft} \]

2b. If the fulcrum for the lever is 9” tall, and the lifting point on the car is 6” above the ground, what is the highest he can raise the car’s wheels off the ground? Assume the wheels move with the car (no suspension).

\[ h_{\text{lifted}} = h_1 - 6 \text{ in} \]

\[ \frac{h_1}{L} = \frac{h_f}{L_2}, \quad \frac{9 \text{ in}}{10 \text{ in}} = \frac{9 \text{ in}}{9 \text{ in}}, \quad h_1 = 10 \text{ in} \]

\[ h_{\text{lifted}} = 10 \text{ in} - 6 \text{ in} \]

\[ h_{\text{lifted}} = 4 \text{ in} \]

2c. After placing the lever beneath the car at the lifting point, but before beginning to lift, how high will the long end of the lever be above the ground?

\[ h_2 = 6 \text{ in} + y \]

\[ \frac{y}{L} = \frac{3 \text{ in}}{L_1}, \quad \frac{y}{10 \text{ in}} = \frac{3 \text{ in}}{1 \text{ in}}, \quad y = 30 \text{ in} \]

\[ h_2 = 6 \text{ in} + 30 \text{ in} \]

\[ h_2 = 36 \text{ in} = 3 \text{ ft} \]
3. While fishing in the gulf, the captain notices that the boat is taking on water. You need to estimate how much longer before the 24-foot-long boat sinks. Your boat has a triangular cross-section and is 10 feet wide at the top and 6 feet deep. Also, you know that the boat and its contents weigh 25,680 lbs. If the leak started 30 minutes ago and the water is now 6” deep, how many hours from now will the boat sink? Should you recommend that the captain keep fishing or head for shore? The unit weight of saltwater = 64.2 pcf.

Boat Length = \( L = 24' \)
Width of boat at top = \( b = 10' \)
Depth of boat = \( h = 6' \)
Weight of boat and contents = \( W = 25,680 \) lb

Now:

\[
A_{\text{now}} = \frac{1}{2} b (0.5') \]

from similar triangles: \( \frac{b}{0.5'} = \frac{10'}{6'} \), \( b = 8.33' \)

\[
A_{\text{now}} = \frac{1}{2} (8.33')(0.5') = 0.2083 \text{ ft}^2
\]

At imminent sinking:

\( W = B \)

\( B = \text{weight of water displaced} = (\text{unit wt water})(V_{\text{displaced}}) \)

\[
V_{\text{displaced}} = V_{\text{boat}} - V_{\text{water inside}}
\]

\[
= \frac{1}{2} (10')(6')(24') - \frac{1}{2} (b_s)(d_s)(24') = 720 \text{ ft}^3 - 12'b_s d_s
\]

from similar triangles: \( \frac{b_s}{d_s} = \frac{10'}{6'} \), \( b_s = \frac{10}{6}d_s \)

\[
25,680 lb = (64.2 \frac{lb}{ft^3}) \left[ 720 \text{ ft}^3 - (12' \left(\frac{10}{6}d_s\right))d_s \right], \quad d_s = 4.0'
\]

Total time to sink boat = \( T \)

\[
\frac{T}{A_{\text{sinking}}} = \frac{0.5 \text{ hr}}{0.2083 \text{ ft}^2}
\]

\[
A_{\text{sinking}} = \frac{1}{2} b_s d_s = \frac{1}{2} \left(\frac{10}{6}\right)(4')(4') = 13.33 \text{ ft}^2
\]

\[
\therefore T = (0.5 \text{ hr}) \frac{13.33 \text{ ft}^2}{0.2083 \text{ ft}^2} = 32.0 \text{ hr}, \quad \text{The boat will sink in } 32.0 \text{ hr} - 0.5 \text{ hr} = 31.5 \text{ hr} \text{ from now}
\]