1. 
   a) Let \( V_s \) be the volume of Santa. Since 60% of Santa is above water, we know that 40% of his volume is below the water. So Santa displaces a volume of water equal to 40% of his total volume, i.e., \( V_d = 0.4V_s \). Thus, the buoyant force acting on Santa is \( F_b = \rho_{\text{water}} \cdot V_d \cdot g = \rho_{\text{water}} \cdot 0.4V_s \cdot g \). We also know that Santa's weight pushes him back down. Since Santa is floating, he is not moving up or down. So \( \Sigma F = 0 \) for forces acting on Santa.
   
   So \( \Sigma F = F_b - W = \rho_{\text{water}} \cdot 0.4V_s \cdot g - mg = 0 \). Now, recall the definition of density: \( \rho = \frac{m}{V} \). So \( m = \rho V \). So \( Msanta = \rho_{\text{water}} V_{\text{water}} \). So \( \rho_{\text{water}} \cdot 0.4V_s \cdot g - \rho_{\text{santa}} \cdot V_{\text{santa}} \cdot g = 0 \).
   
   Solving for \( \rho_{\text{santa}} \), we have \( \rho_{\text{santa}} = 0.4 \times \rho_{\text{water}} = 0.4 \times 1000 \text{ kg/m}^3 = 400 \text{ kg/m}^3 \).

   b) We know that (1) \( m_{\text{santa}} = M_{\text{fat}} + M_{\text{other}} \) and (2) \( V_{\text{santa}} = V_{\text{fat}} + V_{\text{other}} \) and that (3) \( m = \rho V \). So using (2) to rewrite (1), we have:
   
   \( V_s \cdot \rho_s = V_f \cdot \rho_f + V_o \cdot \rho_o \).
   
   Now we can solve (2) for \( V_{\text{other}} \):
   
   \( V_{\text{other}} = V_{\text{santa}} - V_{\text{fat}} \).
   
   So, using this in (4), yields
   
   \( V_o \rho_s = V_f \rho_f + (V_s - V_f) \rho_o \).
   
   \( V_o \rho_s = V_f \rho_f + V_s \rho_o - V_f \rho_o \)
   
   \( V_o = \frac{(V_s - \rho_o)}{(\rho_f - \rho_o)} V_f \).

   \( V_f/V_s \) is the percentage of Santa that is fat. Using \( \rho_s = 400 \text{ kg/m}^3 \), \( \rho_f = 500 \text{ kg/m}^3 \), and \( \rho_o = 300 \text{ kg/m}^3 \), we see that \( V_f/V_s = 0.5 \), so Santa is 50% fat.

   A quicker way to solve it is to notice that the total density is a weighted average of the component densities, where the weights are the percentages. If Santa's fat percentage is \( x \), his "other" percentage is \( 1-x \). So \( \rho_s = x \rho_f + (1-x) \rho_o \). Solving for \( x \) gives the same answer.
c) We can use the same idea we used for part b, except that \( V_d = 0.17 \) \( V_s \) and we have \( \rho \) _chocolate_ instead of \( \rho \) _water_.

So \( \rho \text{c} \cdot 0.17 \ V_s \cdot g = \rho \text{s} \cdot \ V_s \cdot g \ \Rightarrow \ \rho \text{c} = \rho \text{s} / 0.17 \)

So \( \rho \text{c} \approx 571 \ \text{kg}/\text{m}^3 \)

2. We will use Bernoulli's Equation:
\[
P_1 + \frac{1}{2} \rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho V_2^2 + \rho g h_2
\]
Choose point 1 to be the top and point 2 to be the hole.

So \( P_1 = \text{atmospheric} \), \( V_1 = 0 \), \( h_1 = 5 \) cm

and \( P_2 = \text{atmospheric} \), \( V_2 = V \), \( h_2 = 0 \) cm

So \( \text{atmospheric} + \frac{1}{2} \rho (0)^2 + \rho g (5 \text{ cm}) = \text{atmospheric} + \frac{1}{2} \rho V^2 + \rho g (0) \)

\[ \Rightarrow \ \rho g (5 \text{ cm}) = \frac{1}{2} \rho V^2 \]

\[ \Rightarrow \ \rho \approx \frac{4.9 \text{ m/s}^2 \times 0.05 \text{ m}}{V^2} \]

\[ \Rightarrow \ V \approx 1 \text{ m/s} \ \text{(The answer will be the same regardless of where zero height is or whether point 1 is top or bottom.)} \]

3. From Pascal's principle, we know that the pressure everywhere is constant, so \( P_1 = P_2 \). But the definition of pressure is \( p = F/A \), so \( F_1 = F_2 \).

So \( F_2 = \left( \frac{A_2}{A_1} \right) F_1 = \left( \frac{0.5 \text{ m}^2}{0.1 \text{ m}^2} \right) \cdot 1 \text{ N} = 50,000 \text{ N} \)

4. We know that \( P = P_o + \rho g h \). So \( 5000 \text{ Pa} = 0 + \rho \_w \cdot g \cdot h \)

\[ \Rightarrow h = 0.510204 \text{ m} \ \text{[make sure } \rho \text{ is in kg/m}^3 \text{ because } g \text{ is in m/s}^2] \]

\( P_o = 0 \) because gauge pressure is relative to atmospheric pressure.

So the pressure for ethyl alcohol will be
\[ \rho \text{c} = \rho \_o + \rho \_g h = 0 + 800 \text{ kg/m}^3 \cdot 9.8 \text{ m/s}^2 \cdot 0.510204 \]

\[ = 4000 \text{ Pa} \]

5. See http://zebu.uoregon.edu/~probs/mech/flustat/FluDy2/FluDy2.html