31. $d = \frac{m}{V} = \frac{8.19\,g}{3.50\,mL} = \mathbf{2.34\ \frac{g}{mL}}$, or: $d = \frac{8.19\,g}{3.50 \times 10^{-3}\,L} = \mathbf{2.34 \times 10^3\ \frac{g}{L}}$

32. $V = \frac{m}{d} = \frac{125\,g}{7.86 \times 10^3\,g/L} = \mathbf{0.0159\ L}$ or $\frac{125\,g}{7.86 \times 10^3\,g\,L} = 0.0159\,L \times \frac{1\,mL}{1 \times 10^{-3}\,L} = \boxed{15.9\,mL}$

33. $m = d \cdot V = 961\ \frac{g}{L} \times 0.2000\ L = \mathbf{192\ g}$

34. $V = \frac{m}{d} = \frac{46\,g}{789\,g/L} = \mathbf{0.058\ L}$ or $0.058\,\cancel{L} \times \frac{1\,mL}{1 \times 10^{-3}\,\cancel{L}} = \boxed{58\,mL}$

35. $m = d \cdot V = 0.900\ \frac{g}{L} \times 22.4\ L = \mathbf{20.2\ g}$

36. $V_{SPHERE} = \frac{m}{d} = \frac{70.0\,g}{7.20 \times 10^3\,g/L} = 0.00972\ L = 9.72\ mL$

$V_{TOTAL} = V_{SPHERE} + V_{START} = 9.72 + 54.0 = \mathbf{63.7\ mL}$

37. Since less dense liquids float on more dense liquids, the least dense layer will be at the top and the most dense layer will be at the bottom, as shown below. The order is: Z, Y, W and X on the bottom.

$d_Z = \frac{m}{V} = \frac{74.8\,g}{115.0\,mL} = 0.650\ \frac{g}{mL}$ $d_W = \frac{m}{V} = \frac{107.3\,g}{55.0\,mL} = 1.95\ \frac{g}{mL}$

$d_Y = \frac{m}{V} = \frac{46.8\,g}{42.5\,mL} = 1.10\ \frac{g}{mL}$ $d_X = \frac{m}{V} = \frac{51.8\,g}{12.0\,mL} = 4.32\ \frac{g}{mL}$

38. Although the density of iron is greater than the density of water, the fact that the boat floats means the density of the boat must be less than the density of the water. Since $d = m/V$, then in order for the density of the boat to be less than 1 g/mL (water's density), the volume occupied by the boat must be quite large, relative to its mass. This situation is obtained by having a shape which keeps water out of the center of the boat, allowing most of the interior volume to be air (and other stuff inside the boat The AVERAGE density of the entire boat, including iron hull, air, etc. is then less than 1 g/mL.

39. $V_{COPPER} = \frac{m}{d} = \frac{100.0\,g}{8.92 \times 10^3\,g/L} = 0.01121\ L = V_{MAGNESIUM}$

$m_{MAGNESIUM} = d \cdot V = 1.74 \times 10^3\ \frac{g}{L} \times 0.01121\ L = \mathbf{19.5\ g}$

40. mass of sun $= d \cdot V = 1.407\ \frac{g}{mL} \times \frac{1\,kg}{10^3\,g} \times \frac{1\,t}{10^3\,kg} \times \frac{1\,mL}{10^{-3}\,L} \times 1.41 \times 10^{30}\ L = 1.98 \times 10^{27}\ t$

time required $= 1.98 \times 10^{27}\ t \times \frac{1\,s}{4.0 \times 10^6\,t} \times \frac{1\,y}{3.15 \times 10^7\,s} = 1.6 \times 10^{13}\ y$

41. $V_{SODIUM} = \frac{m}{d} = \frac{90.0\,g}{970.0\,g/L} = 0.0928\ L = 92.8\ mL$

After inserting the cube, the remaining volume is less.

$V_{REMAINING} = V_{START} - V_{SODIUM} = 250.0 - 92.8 = 157.2\ mL$; $d_{ARGON} = \frac{m}{V} = \frac{4.60\,g}{157.2\,mL} = \mathbf{0.0293\ \frac{g}{ml}}$