Name: Key
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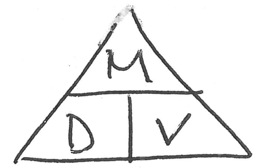
Chemistry 11
DENSITY

Density is defined as the MASS contained in a given VOLUME of a substance.

Mass – measured in grams
Volume – measured in mL.



To calculate density we use a "MATHEMATICAL PYRAMID"

D = M ÷ V

D = $M \div V \therefore g/mL$

M = $D \times V \therefore \frac{g}{\cancel{mL}} \times \cancel{mL} = g$

V = $\frac{M}{D} \therefore \cancel{g} \times \frac{1\ mL}{\cancel{g}} = mL$

Example 1. An Iron bar has a mass of 19 600 g and a volume of 2.50 L . What is the density of the Iron Bar?

$D = M \div V \therefore \frac{19\,600g}{2.50\ L} \times \frac{1 \times 10^{-3} L}{1\ mL} = \boxed{7.84\ g/mL}$

IMPORTANT FACTS!!!

i. The volume of a liquid is meaured in mL

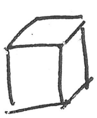
ii. The volume of a solid is measured in cm^3

In GENERAL 1 mL = 1 cm^3

iii. The density of PURE WATER (@ 4°C)is 1.000 g/mL

iv. A substance with a density greater that 1 g /mL will SINK in water

v. A substance with a density smaller that 1 g /mL will FLOAT in water



Example 2. A brass cube has a density of 8 g/mL and is 2 cm on each side.

a. What is the volume of this brass cube?

$V = 2cm \times 2cm \times 2cm = 8cm^3 = 8\ mL$

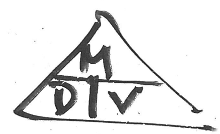
b. Calculate the mass of this brass cube.

$M = d \times V \therefore 8 g/\cancel{mL} \times 8\cancel{mL} = 64$ grams

c. State whether this cube will float or sink in liquid mercury (density = 13.6 g/mL)

B/c 8g/mL is less than 13.6g/mL the cube will FLOAT in liquid mercury!

DENSITY PROBLEMS KEY

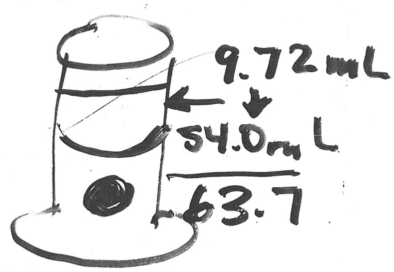


31. $d = \frac{m}{V} = \frac{8.19\,g}{3.50\,mL} = \boxed{2.34\ \frac{g}{mL}}$ or: $d = \frac{8.19\,g}{3.50 \times 10^{-3}\ L} = \boxed{2.34 \times 10^{3}\ \frac{g}{L}}$

32. $V = \frac{m}{d} = \frac{125\,g}{7.86 \times 10^{3}\ g/L} = \boxed{0.0159\ L}$ or $\frac{1\,mL}{1\times10^{-3}L} = \boxed{15.9\ mL}$

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

34. $V = \frac{m}{d} = \frac{46\,g}{789\ g/L} = \boxed{0.058\ L}$ $\frac{1\,mL}{1\times10^{-3}\ L} = \boxed{58\ mL}$



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

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

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

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.

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

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

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

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

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

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.

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