FITCH

Part 4 – Density Calculations.

a) Diamonds (a form of carbon) are measured in carats, and 1 carat = 0.200 g. What is the mass of a 5 carat diamond?

$(5 \text{ CARAT})\left(\frac{.2\text{g}}{\text{CARAT}}\right) = 1.0\text{g}$

b) If the density of diamond is 3.51 g/cm³, what would the volume of the 5 carat diamond from the last problem?

$D = \frac{M}{V} \Rightarrow V = \frac{M}{D} = \frac{1\text{g}}{3.51\text{g/cm}^3} = .2849\text{ cm}^3 = .28\text{ cm}^3$

c) The volume of a diamond is found to be 2.8 mL. What is the mass of the diamond in carats?

$D = \frac{M}{V} \quad V \cdot D = M = (2.8\text{ mL})\left(3.51\frac{\text{g}}{\text{mL}}\right) = 9.828\text{ g}$

$(9.828\text{g})\left(\frac{1\text{ CARAT}}{.2\text{g}}\right) = 49.14\text{ CARATS}$

d) Hydrogen gas (H_2) at 0°C and 1 atmosphere pressure has a density of 0.0899 g/L. What is the density in g/cm³?

$\left(.0899\frac{\text{g}}{\text{L}}\right)\left(\frac{1\text{L}}{1000\text{mL}}\right) = .0000899\text{ g/cm}^3 = 8.99\times10^{-5}\text{ g/cm}^3$

e) What volume would 2.02 grams of hydrogen occupy?

$V = \frac{M}{D} = \frac{2.02\text{g}}{8.99\times10^{-5}\text{g/cm}^3} = 22469.4\text{ cm}^3$

f) What mass of hydrogen would be required to fill the Hinderberg? (the volume of the great air ship was 2 x 10⁵ cubic meters)

$D = \frac{M}{V}$

$V \cdot D = M$

$(2\times10^5\text{m}^3)\left(\frac{1{,}000{,}000\text{cm}^3}{\text{m}^3}\right) = 2\times10^{11}\text{cm}^3 = V$

$(2\times10^{11}\text{cm}^3)(8.99\times10^{-5}\text{g/cm}^3) = 17980.000\text{g} = 1.798\times10^7\text{g}$

$1.798\times10^4\text{kg}$

g) The density of aluminum is 2.70 g/cm³. Express this value in units of kilograms per cubic meter?

$\left(2.7\frac{\text{g}}{\text{cm}^3}\right)\left(\frac{1\text{kg}}{1000\text{g}}\right)\left(\frac{1000000\text{ cm}^3}{\text{m}^3}\right) = 2700\frac{\text{kg}}{\text{m}^3}$

h) The diameter of a hydrogen nucleus is 1.0 X 10⁻¹⁵ meters and its mass is 1.67 X 10⁻²⁴ grams. What is the density of the nucleus in g/cm³?

VOLUME SPHERE $= 4/3\,\pi r^3$ $\quad r = .5\times10^{-15}\text{m} =$

$(.5\times10^{-15}\text{m})\left(\frac{100\text{cm}}{\text{m}}\right) = 50\times10^{-15}\text{cm} = 5.0\times10^{-14}\text{cm} = r$

$V = 4/3\,\pi(5.0\times10^{-14}\text{cm})^3 = 5.23598\ldots\times10^{-40}\text{cm}^3 = V \quad D = \frac{M}{V} = \frac{1.67\times10^{-24}\text{g}}{5.2359\ldots\times10^{-40}\text{cm}^3}$

$= 3.1894\ldots\times10^{15}\text{ g/cm}^3$

$= 3.19\times10^{15}\text{ g/cm}^3$