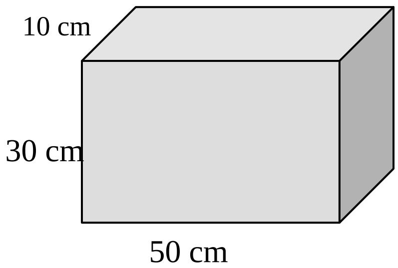
1. Converting Units



a) Calculate the volume of the cube in cm^3.

$$\mathbf{(10\ cm)(30\ cm)(50\ cm) = 15{,}000\ cm^3}$$

b) Convert the volume to m^3.

$$\mathbf{(15{,}000\ cm^3)\left(\frac{1\,m}{100\ cm}\right)^3 = 0.015\ m^3}$$

c) Convert: 18 Tg/yr to kg/hr and g/sec (1 Tg=10^{12} g)

$$\left(\frac{18\ Tg}{yr}\right)\left(\frac{10^{12}\ g}{Tg}\right)\left(\frac{1\,kg}{1000\,g}\right)\left(\frac{1\ yr}{365\,day}\right)\left(\frac{1\,day}{24hr}\right) = 2.05\times10^6\ {}^{kg}\!/_{hr}$$

$$\left(\frac{18\ Tg}{yr}\right)\left(\frac{10^{12}\ g}{Tg}\right)\left(\frac{1\ yr}{365\,day}\right)\left(\frac{1\,day}{24hr}\right)\left(\frac{1\ hr}{3600\ sec}\right) = 5.71\times10^5\ {}^{g}\!/_{sec}$$

2. Concentration and Mixing Ratio

Assume you have a cube whose sides' measure 1 meter (volume of 1 m^3). In that cube you have 40 balls. Four of these balls are green. What is the mixing ratio of the green balls in the cube? What is the concentration of the green balls in the cube?

The mixing ratio of green balls is the number of green balls (4) divided by the total number of balls (40): MR=4 balls/40 balls=0.1
The concentration of the green balls is the number of green balls divided by the volume of the cube: C= 4 balls/1 m^3= 4 balls/m^3

Take the cube from the previous question and double its volume, with the number of balls remaining unchanged. What is the mixing ratio of the green balls in the cube? What is the concentration of the green balls in the cube?

The mixing ratio does not depend on volume, only on the number of balls. So we still have: MR = 4 green balls / 40 balls = 0.1
The concentration of green balls in this new volume of 2 m^3 will be: C_{new}=4 balls/2 m^3 = 2 balls/m^3, compared to what we calculated above, C=4 balls/m^3.

Take the cube from the previous question and add 40 new balls (12 of them green), with the volume remaining at 2 m^3. What is the mixing ratio of the green balls in the cube? What is the concentration of the green balls in the cube?

The mixing ratio of green balls is the number of green balls (4+12=16) divided by the total number of balls (40+40=80): MR=16 balls/80 balls=0.2
The concentration of the green balls is the number of green balls divided by the volume of the cube: C= 16 balls/2 m^3= 8 balls/m^3

3. Mixing Ratio to Concentration

The atmosphere contains approximately 385 ppmv carbon dioxide (CO_2). What is the concentration, in g/cm^3, of carbon dioxide? Assume that the density of air is 2.5×10^{19} molecules/cm^3.

Useful information: 1 mole = 6.02×10^{23} molecules;
Molecular weight of carbon dioxide is 44 g/mole

$$\left(\frac{\textbf{385 molec. CO}_2}{\textbf{1}\times\textbf{10}^6\textbf{ molec. air}}\right)\left(\frac{\textbf{2.5}\times\textbf{10}^{19}\textbf{ molec. air}}{\textbf{1 cm}^3}\right)\left(\frac{\textbf{44 g CO}_2}{\textbf{1 mole CO}_2}\right)\left(\frac{\textbf{1 mole CO}_2}{\textbf{6.02}\times\textbf{10}^{23}\textbf{ molec. CO}_2}\right)=\textbf{7.03}\times\textbf{10}^{-7}\frac{\textbf{g. CO}_2}{\textbf{cm}^3}$$

4. Concentration to Mixing Ratio

A detector measures 1.25×10^{-10} g/cm^3 of Ozone (O_3) on roof of this building. What is the mixing ratio in ppbv? Assume that the density of air is 2.5×10^{19} molecules/cm^3.

Useful information: 1 mole = 6.02×10^{23} molecules;
Molecular weight of ozone is 48 g/mole

$$\left(\frac{\textbf{1.25}\times\textbf{10}^{-10}\textbf{ g O}_3}{\textbf{cm}^3}\right)\left(\frac{\textbf{1 cm}^3}{\textbf{2.5}\times\textbf{10}^{19}\textbf{ molec. air}}\right)\left(\frac{\textbf{1 mole O}_3}{\textbf{48 g O}_3}\right)\left(\frac{\textbf{6.02}\times\textbf{10}^{23}\textbf{ molec. O}_3}{\textbf{1 mole O}_3}\right)=\textbf{6.27}\times\textbf{10}^{-8}\frac{\textbf{molec. O}_3}{\textbf{molec. air}}=\textbf{62.7 ppbv}$$