# CO2 Concentration from Carbon Weight

***Note:*** ChatGPT 4.0 was consulted while making this calculation. It's answers were manually evaluated, tweaked and checked for correctness.

Let volume of the atmosphere be $4.2 \times 10^{18}\ \mathrm{m}^3$ (Quora, 2024) and let the weight of carbon in the air be $750\ \mathrm{GtC}$ (S. Rackley, Science Direct, 2023). Further, let all carbon in the air be in the form of $CO_2$.

Given these assumptions, the concentration of $CO_2$ in the atmosphere can be computed by following steps given below.

## Step 1: Mass

This step involves calculating the mass of $CO_2$ corresponding to $750\ \mathrm{GtC}$.

Atomic mass of carbon $(C) = 12\ \mathrm{g/mol}$.

Molar mass of $CO_2 (C + 2 \times O) \approx 12 + 2 \times 16 \approx 44\ \mathrm{g/mol}$.

The ratio of the mass of $CO_2$ to the mass of carbon in $CO_2$ is $\frac{44}{12} = 3.67$.

$\therefore$ Mass of $CO_2$ corresponding to $750\ \mathrm{GtC} = 750 \times 3.67 = 2752.5\ \mathrm{GtCO2}$

Since $1\ \mathrm{Gt} = 10^{15}\ \mathrm{g}$, $2752.5\ \mathrm{GtCO2} = 2752.5 \times 10^{15}\ \mathrm{gCO2}$.

## Step 2: Molar Mass

The no. of moles of $CO_2 = \frac{2752.5 \times 10^{15}\ \mathrm{g}}{44\ \mathrm{g/mol}} = 6.26 \times 10^{16}\ \mathrm{moles}$.

## Step 3: Volume

As per the ideal gas law, at standard temperature and pressure (STP), 1 mole of gas occupies $22.414\ \mathrm{L}$.

Thus, total volume of $CO_2 = 6.26 \times 10^{16}\ \mathrm{L} \times 22.414\ \mathrm{L/mole} = 1.4 \times 10^{18}\ \mathrm{L}$.

In $m^3$, volume of $CO_2 = 1.4 \times 10^{18}\ \mathrm{L} \times 10^{-3}\ \mathrm{m^3/L} = 1.4 \times 10^{15}\ \mathrm{m}^3$

## Step 4: Concentration

Using now available values, concentration of $CO_2$ in parts per million $(ppm)$, can be computed as follows.

$$Con_{CO_2} = \frac{\text{Volume of } CO_2}{\text{Volume of Atmosphere}} \times 10^6$$

$$\Rightarrow Con_{CO_2} = \frac{1.4 \times 10^{15}\ \text{m}^3}{4.2 \times 10^{18}\ \text{m}^3} \times 10^6 = \frac{1.4}{4.2} \times 10^3 = 0.33333 \times 10^3 = 333.33\ \text{ppm}$$