



Dust particles can cause many serious diseases when inhaled, and lead to millions of premature deaths each year around the world. The dust particles are less than 2.5 micrometers in diameter (one tenth the diameter of human hair) and are present in the atmosphere in many geographic locations.

For the first time, the Terra Satellite's MISR and MODIS instruments were able to compile a map of the concentration of these deadly particles around the world. The figure above shows the concentration over the United States.

Problem 1 - The color scale gives the concentration of these dust particles in micrograms per cubic meter of air. Suppose these dust grains are perfect spheres with a density of 2000 kilograms per cubic meter. How many dust particles are present in a cubic meter of air at a concentration of 15 micrograms per cubic meter?

Problem 2 - A normal human breath is about 1 liter of gas volume. How many dust particles at a concentration of 15 micrograms/meter³ are taken in with each breath?

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Answer: First we have to determine the mass of a single dust particle. Since mass = density x volume, and for a sphere volume = $\frac{4}{3} \pi R^3$, we have for a 2.5 micron diameter dust particle $R = 1.25 \times 10^{-6}$ meters and so:

$$V = 1.33 (3.141) (1.25 \times 10^{-6} \text{ meters})^3 \text{ so}$$

$$V = 8.2 \times 10^{-18} \text{ meter}^3.$$

$$\text{Density} = 2000 \text{ kg/meter}^3 \text{ so}$$

$$\text{Mass} = 8.2 \times 10^{-18} \text{ meter}^3 \times 2000 \text{ kg/meter}^3$$

$$= 1.6 \times 10^{-14} \text{ kilograms.}$$

In terms of micrograms this becomes

$$M = 1.6 \times 10^{-14} \text{ kg} \times (1000 \text{ gm/1kg}) \times (1 \text{ microgram}/10^{-6} \text{ grams})$$

$$= 1.6 \times 10^{-5} \text{ micrograms/particle}$$

The concentration is 15 micrograms/meter³, so the particulate density is then

$$N = 15 \text{ micrograms/meter}^3 \times (1 \text{ particle} / 1.6 \times 10^{-5} \text{ micrograms})$$

$$= 9.4 \times 10^5 \text{ particles/meter}^3.$$

This means that one cubic meter can contain **nearly 1 million particles of dust!**

Problem 2 - A normal human breath is about 1 liter of gas volume. How many dust particles at a concentration of 15 micrograms/meter³ are taken in with each breath?

Answer: From Problem 1, this concentration equals 940,000 dust particles per cubic meter. Since 1 liter is 0.001 cubic meters, a single breath takes in about **940 dust particles at this concentration!**

More details can be found at 'New Map Offers Global View of Health-Sapping Air Pollution';

<http://www.nasa.gov/topics/earth/features/health-sapping.html>

"Human-generated particles often predominate in urban air -- what most people actually breathe -- and these particles trouble medical experts the most, explained Arden Pope, an epidemiologist at Brigham Young University, Provo, Utah and one of the world's leading experts on the health impacts of air pollution. That's because the smaller PM_{2.5} particles evade the body defenses—small hair-like structures in the respiratory tract called cilia and hairs in our noses—that do a reasonably good job of clearing or filtering out the larger particles.