AQI	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	Air Quality Descriptor
0–50	0.0–15.4	0–54	Good
51–100	15.5–40.4	55–154	Moderate
101–150	40.5–65.4	155–254	Unhealthy for Sensitive Groups
151–200	65.5–150.4	255–354	Unhealthy
201–300	150.5–250.4	355–424	Very unhealthy

Because of their impacts to health, the US Environmental Protection Agency monitors the level of aerosols in the atmosphere (troposphere) for two categories: Large aerosols (PM_{10}) with diameters near 10 microns, and small aerosols ($PM_{2.5}$) with diameters near 2.5 microns (μm). The Air Quality Index (AQI) relates the density of each aerosol type (measured in micrograms per cubic meter or μg/m^3) to health risk as shown in the table above.

Problem 1 - Suppose the two types of aerosol particles have a density of 2000 kg/m^3. Assuming that each particle is a perfect sphere, what are the average masses of each type of aerosol particle in kilograms?

Problem 2 – Based on your estimate of the aerosol particle masses in Problem 1, how many aerosol particles of each type would be present in a 1 cubic meter volume of air of the AQI was 150?

Problem 1 - Suppose the two types of aerosol particles have a density of 2000 kg/m^3. Assuming that each particle is a perfect sphere, what are the average masses of each type of aerosol particle in kilograms?

Answer: Volume = $4/3\ \pi\ R^3$,

$PM_{2.5}$ aerosols: For R = 1.3 microns, R = 1.3×10^{-6} meters so
V = $1.333 \times 3.141 \times (1.3\times10^{-6}\ m)^3$
= $9.2\times10^{-18}\ m^3$.

Mass = density x volume, so

M = $2000 \times 9.2\times10^{-18}$
= **1.8×10^{-14} kilograms.**

PM_{10} aerosols: R = 5 microns so

V = $1.333 \times 3.141 \times (5.0\times10^{-6}\ m)^3$
= $5.2\times10^{-16}\ m^3$, then

Mass = $2000 \times 5.2\times10^{-16}$
= **1.0×10^{-12} kilograms.**

Problem 2 – Based on your estimate of the aerosol particle masses in Problem 1, how many aerosol particles of each type would be present in a 1 cubic meter volume of air of the AQI was 150?

Answer: The table indicates that for an AQI of 150, the density of the PM_{10} particles would be 254 $\mu g/m^3$. Since the mass of such an aerosol particle is about 1.0×10^{-12} kilograms, we have

N = $2.54\times10^{-6}\ \mu g/m^3 \times (1\ kg/1000\ gm) \times (1\ particle/1.0\times10^{-12}\ kg)$
= **2500 particles/meter^3.**

The table indicates that for an AQI of 150, the density of the $PM_{2.5}$ particles would be 65.4 $\mu g/m^3$. For $PM_{2.5}$ aerosols the density is 65.4 mg/m^3. The average mass is 1.8×10^{-14} kg, so

N = $65.4\times10^{-6}\ \mu g/m^3 \times (1\ kg/1000\ gm) \times (1\ particle/1.8\times10^{-14}\ kg)$
= **3.6×10^6 particles/meter^3**.