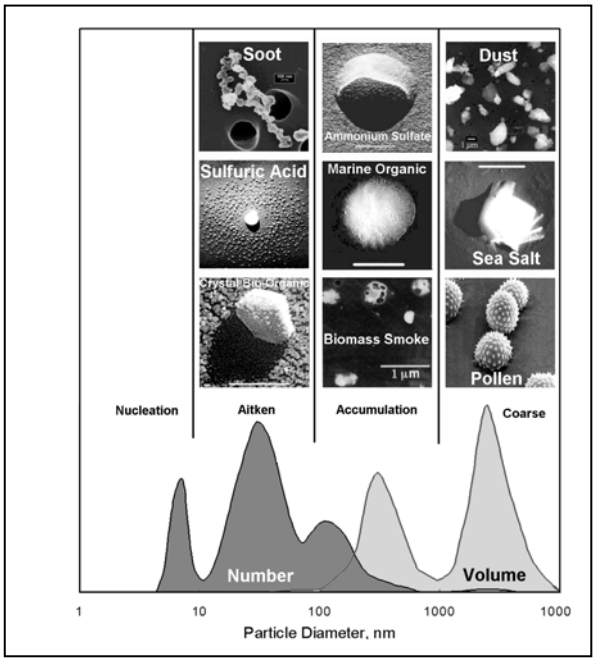

An aerosol is a mixture of fine solid particles or liquid droplets in air or another gas. Examples of aerosols include clouds, haze, and air pollution such as smog and smoke. The liquid or solid particles have diameter mostly smaller than 1 µm or so.

Aerosols are so small we have no real choice but to use scientific notation to determine their properties such as volume, mass or density! The graph to the left shows the sizes of different types of aerosols in terms of nanometers, where 1 nanometer is 1 one billionth of a meter or 10^{-9} meters.

Problem 1 – A human hair has a diameter of 100 micrometers (100 microns). If 1000 nanometers equals 1 micron, how many 250 nanometer aerosol particles can fit across the diameter of one human hair?

Problem 2 – If the density of a typical spherical sea salt aerosol particle is 2.0 grams/cm^3, and the particle has a diameter of 500 nanometers, what is the mass of a single aerosol particle in A) grams? B) micrograms?

Problem 3 - On an especially hazy day, the density of aerosol particles in the air is 10 million particles per cubic centimeter. If the particles have an average size of 900 nanometers and a density of 1.5 grams/cm^3, A) how much aerosol mass would there be in a cubic meter of air? B) If you breath-in 100 liters of air every minute, and 1 liter equals 1000 cm^3, how many grams of aerosols do you inhale every day?

Problem 1 – A human hair has a diameter of 100 micrometers (100 microns). If 1000 nanometers equals 1 micron, how many 250 nanometer aerosol particles can fit across the diameter of one human hair?

Answer: Diameter of human hair in nanometers = 100 micrometers x (1000 nanometers/1 micrometer) = 100000 nanometers. Since one aerosol is 250 nm in diameter, there would be 100000/250 = **400 aerosol particles** place end to end to cross the diameter of one human hair.

Problem 2 – If the density of a typical spherical sea salt aerosol particle is 2.0 grams/cm^3, and the particle has a diameter of 500 nanometers, what is the mass of a single aerosol particle in A) grams? B) micrograms?

Answer: A) The radius of the aerosol is 250 nanometers. Since 1 meter = 100 centimeters, the radius is 250 x 10^{-9} x (100 cm/1 meter) = 2.5x10^{-5} cm. Volume of a spherical particle = 4/3 π (2.5x10^{-5} meters)^3 = 6.5x10^{-14} cm^3. The mass in grams is then 2.0 grams/cm^3 x Volume in cm^3, so **M = 1.3x10^{-13} grams**.

B) 1 microgram = 10^{-6} grams, so **M = 1.3x10^{-7} micrograms**.

Problem 3 - On an especially hazy day, the density of aerosol particles in the air is 10 million particles per cubic centimeter. If the particles have an average size of 900 nanometers and a density of 1.5 grams/cm^3, A) how much aerosol mass would there be in a cubic meter of air? B) If you breath-in 100 liters of air every minute, and 1 liter equals 1000 cm^3, how many grams of aerosols do you inhale every day?

Answer: A) Each particle has a mass of

M = 1.5 gm/cm^3 x (4/3 π (4.5x10^{-5} cm))^3 = 5.7x10^{-13} grams.

If the particle density is 10^7 particles/cm^3, in 1 cubic meter there would be 10^7particles/cm^3 x 10^6 cm^3= 10^{13} particles, and so the total mass per cubic meter would be 5.7x10^{-13} grams x 10^{13} particles = **5.7 grams**!

B) You breath in 100 liters/minute x (1000 cm^3/1 liter) x (60 minutes/1 hour) x (24 hours/1 day) = 1.44x10^8 cm^3. Since the aerosol mass is 5.7 grams/meter^3 we have 1.44x10^8 cm^3 x (1 meter^3/10^6 cm^3) x (5.7 grams/1 meter^3) = 144 x 5.7 = **821 grams/day**.