INTRODUCTION OF AEROSOLS
CHARACTERIZATION, SOURCES & IT'S IMPACTS

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INTRODUCTION

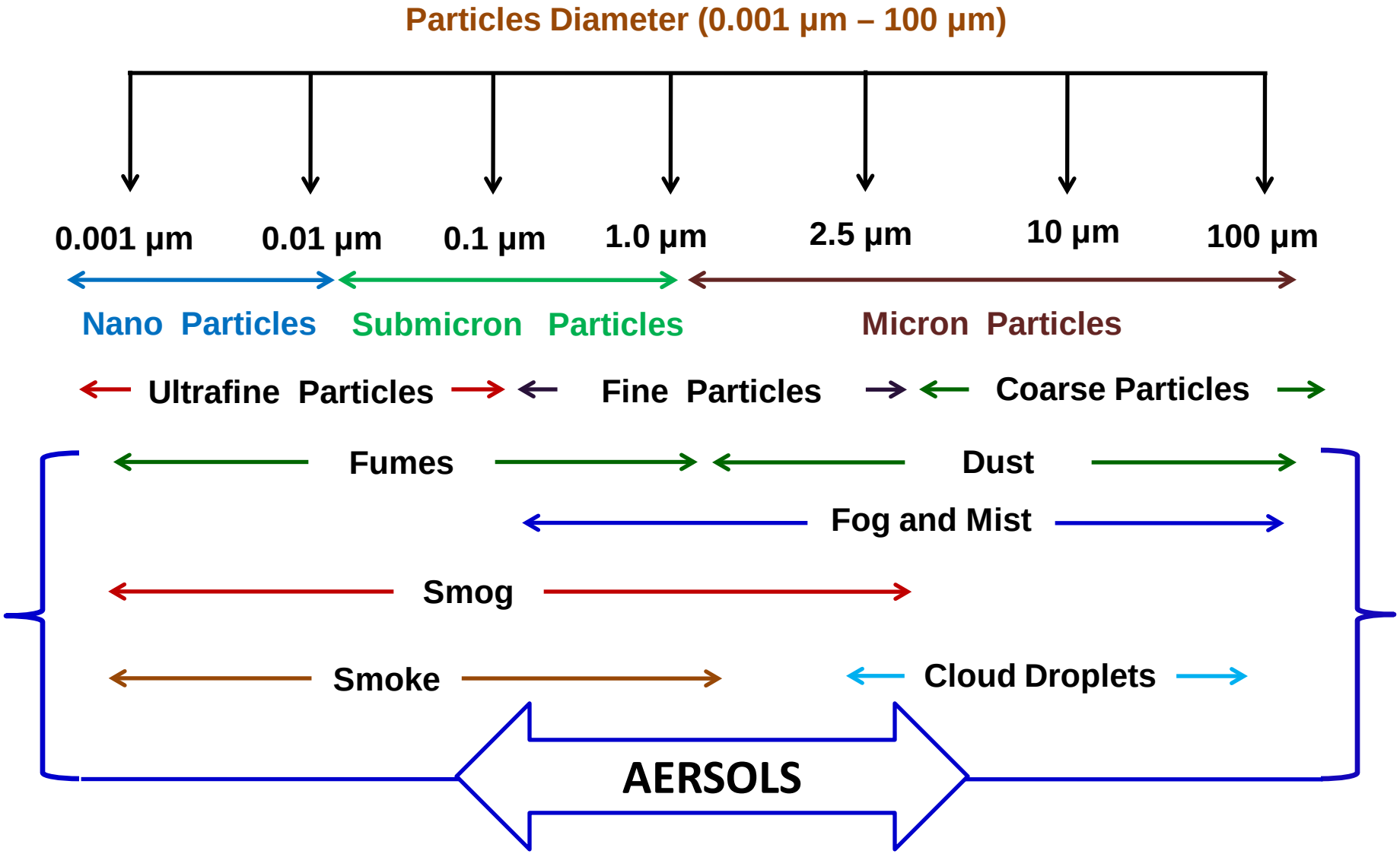
Aerosol-

An aerosol can be defined as a dispersion of solid and liquid particles suspended in gas.

- Aerosol is to be stable for few second to several months.
- The term aerosol includes both the Particulates matter (PM) and suspending gas. Particles size ranges from about 0.002 to more than 100 μm.
- Aerosols occur in both the troposphere and the stratosphere, but there are considerable differences in the size ranges, chemical nature and sources of the aerosols that occur in these two atmospheric layers.
- Many research efforts are under way to measure, characterize and model aerosols. This is because aerosols have important consequences for global climate, ecosystem processes, and human health.

William C. Hinds

SIZE OF AEROSOLS

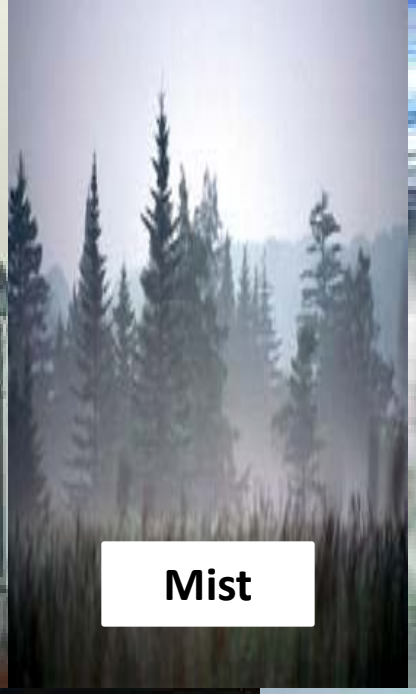


Forms of Aerosols

- **Dust:** Solid particles formed by mechanical breakage of parent materials or crushing. These have irregular shapes and > 1 μm.
- **Fumes:** Particles formed by condensation or chemical reaction. It also refers noxious vapor components. (usually < 1 μm).
- **Fog:** Suspension of water droplets and they are effecting visibility < 1 km.
- **Mist:** Suspension of droplets and they are effecting visibility > 1 km. (< 200 μm)
- **Smog:** Consisting of solid and liquid particles formed by the presence of sunlight on vapors. It is combination of smoke and fog .
- **Smoke:** Visible aerosol from incomplete combustion. Particles may be solid or liquid. (usually < 1 μm)
- **Cloud:** A visible aerosol with defined boundaries. (high density)
- **Haze:** A visibility – reducing aerosol.
- **Primary Aerosols:** Which are emitted directly into the atmosphere.
- **Secondary Aerosols:** Aerosols that arise from gas to particle conversion.


Dust


Fog


Mist


Cloud Droplets


Smog


Smoke


Haze

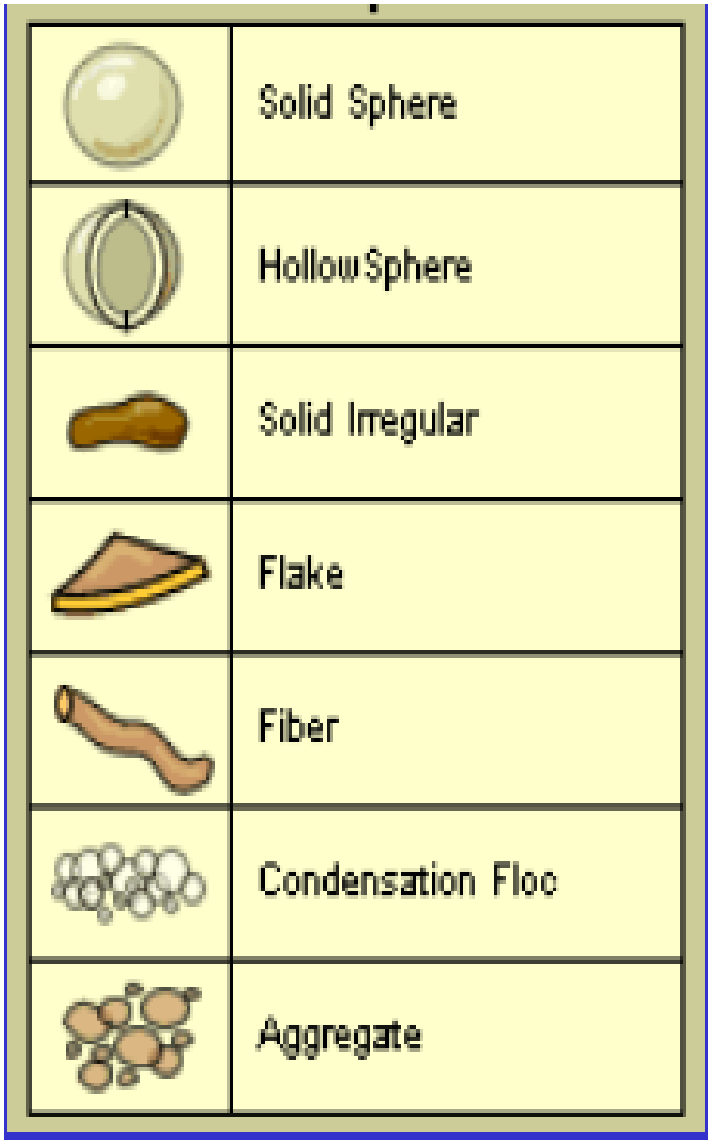
SHAPE AND DENSITY OF AEROSOL

- Aerosols have number of different shape and densities as indicated in figure.

- So, it is necessary to define of these particles. We must standardize to particle size that is relates to how the particle behaves in a fluid such as air.

- The term "aerodynamic diameter" has been developed by aerosol physicists in order to provide a simple means of categorizing the sizes of particles having different shapes and densities with a single dimension.

- The **aerodynamic diameter is** the diameter of a spherical particle having a density of 1 gm/cm3 that has the same inertial properties [i.e. terminal settling velocity].



CONTD..

A solid , spherical particle's gravitational settling velocity is proportional to the particle density, ρ_p , the square of the physical particle diameter , d_p and the Cunningham slip correction factor, C_c . Suspending gas is not a continuous fluid, but consists of discrete molecules.

$$\rho_p C_c (d_p) d_p^2 = \rho_0 C_c (d_a) d_p^2$$

Where $C_c = C_c (d_p) = C_c (d_a)$

$\rho_0 = 1$ g/cm^3 (Standard particle density)

$$d_a = d_p (\rho_p / \rho_0)^{0.5}$$

Example:

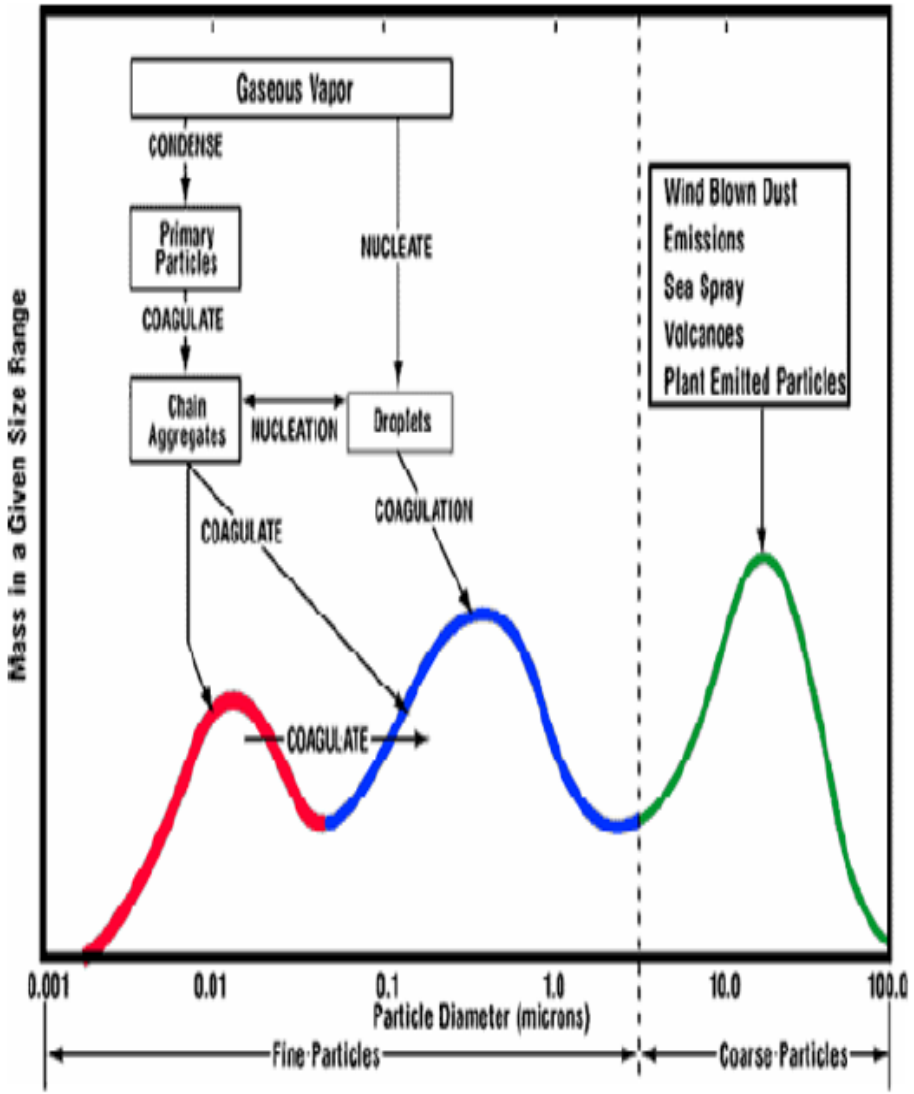
what is the aerodynamic diameter of the spherical particle that is 3 μm in diameter and has the particle density of 4 g/ cm^3 ? Ignore the slip correction factors.

HOW ATMOSPHERIC AEROSOLS ARE FORMED

- The terms *nucleation mode* and *accumulation* mode refer to the mechanical and chemical processes by which aerosol particles in those size ranges are usually produced.

- The smallest aerosols, in the nucleation mode, are principally produced by *gas-to-particle conversion* (GPC), which occurs in the atmosphere.

- Aerosols in the accumulation mode are generally produced by the *coagulation* of smaller particles and by the *heterogeneous condensation* of gas vapor onto existing aerosol particles.



SOURCES OF AEROSOLS

Natural Sources

Chemical reactions in the atmosphere

Anthropogenic Sources

Sources of Aerosols			
Natural Sources		**Anthropogenic Sources**	
Primary	**Secondary**	**Primary**	**Secondary**
Soil dust	Sulfate from biogenic gases	Industrial dust	Sulfate from SO_2
Sea Salt	Sulfate from volcanic SO_2	Vehicles exhaust emissions	Biomass burning
Volcanic Dust	Organic matter from biogenic VOC	Power Plants	Nitrate from NOx
Biological debris	Nitrates from NOx	Mining	Organics from anthropogenic
Forest fires	Photochemical		VOC

AEROSOL AND ITS EFFECTS