Today, we will:

- Discuss **particles** and **particle sizes** [Section 8.1]
- If time, begin to discuss **equations of particle motion** [Section 8.4]
- Do **Candy Questions for Candy Friday**

See thumbnail slide on website — Particle PowerPoint Slide

**Particle size summary**

- Water drops $2 \leq D_p \leq 10,000 \text{ \mu m}$
- Human hair $30 \leq D_p \leq 200 \text{ \mu m}$
- Pollen $10 \leq D_p \leq 100 \text{ \mu m}$
- Non-glowing particles visible to naked human eye $D_p \geq 70 \text{ \mu m}$
- Glowing $D_p \geq 10 \text{ \mu m}$

- Coarse particle
  (Inhalable)
  $D_p \leq 10 \text{ \mu m} \rightarrow \text{PM}_{10}$

- Inhalable Coarse Particle
  $2.5 \leq D_p \leq 10 \text{ \mu m}$

- Respirable particle
  "Fine" particle
  $D_p \leq 2.5 \text{ \mu m}$ — deep into lungs
  $\text{PM}_{2.5}$
- Supermicron particle: $D_p \geq 1 \text{ mm}$
- Submicron: $D_p \leq 1 \text{ mm}$
- Can get into alveoli – need macrophage to remove them

- $D_p \approx 1 \text{ mm} -$ Primarily from grinding/crushing/pulverizing (mechanical process) "just"

- $D_p \leq 1 \text{ mm} -$ Primarily from combustion eg. smoke (burning)

- Visible light wavelength: $0.3 < \lambda < 0.7 \text{ mm}$
- Bacteria: 0.2 to 20 $\mu$m
- Ultratine particle (UFP): $D_p \leq 0.1 \text{ mm}$ (100 nm)
- Mean free path of air molecule: $\lambda \approx 0.06 \text{ mm} @ SATP$
- Viruses: 0.002 to 0.06 $\mu$m
- "Nanoparticles": $D_p \leq 0.05 \text{ mm}$ (50 nm)
- Atom: $2-6 \text{ Angstroms} = 1 \text{ Å} = 10^{-10} \text{ m}$
  \[2 \times 10^{-10} \leq D_p \leq 6 \times 10^{-4} \text{ mm}\]
**Visible Light**

\[ 0.33 \leq D_p \leq 0.70 \, \mu m \]

- Violet
- Red

**Why is the sky blue?**

During the day,

Evening

* Aerosol - a suspension of particles in air (Particle = solid or liquid)
  - Hydrosol - a suspension in water
Concentration:

\[ C_{\text{number}} = \frac{C_i}{M_{\text{particle}}} \]

\[ = \frac{3.4 \times 10^{-7} \text{ mol/m}^3}{\text{m}^3} \]

\[ C_i = 3.4 \times 10^{-7} \text{ mols/particle} \]

\[ M_{\text{particle}} = \frac{\rho}{\text{molar mass}} \]

\[ \rho = 0.6 \text{ g/cm}^3 \]

\[ = 348 \text{ million particles/m}^3 \]

For particles we do not use mol fraction. Use mass, concentration. Mol and conc. C_{number}

\[ \text{Number concentration} = \frac{C_i \times \text{mol}}{V_0} \]

\[ = \frac{\text{mol/particle}}{\text{m}^3} \]

For vapor or gas:

\[ \text{Molar conc. C}_{\text{number}} \]

\[ \text{Mol} = \frac{\text{number of particles}}{\text{mol}} \]
Example: Conversion of number concentration to mass concentration

**Given:** Veronica collects a small sample of dusty air flowing through a duct at a processing plant. The particle material is known and thus the particle density is also known \( (\rho_p = 2340 \text{ kg/m}^3) \). She runs her sample through a particle analyzer and finds that the average particle diameter based on mass, \( D_{p,\text{am}} \text{(mass)} = 12.3 \text{ microns} \). An optical instrument in the duct shows that the average number concentration of particles is 456 million particles/m\(^3\).

**To do:** Estimate the mass concentration of the particles in units of mg/m\(^3\) to three significant digits.

**Solution:** The following equations are useful:

\[
C_{j} = \frac{C_{\text{number, } j} \cdot m_{p,\text{mean}}}{m_{p,\text{mean}}} = \frac{C_{\text{number, } j} \cdot \rho_p \frac{\pi}{6} (D_{p,\text{am}} \text{(mass)})^3}{m_{p,\text{mean}}}
\]

\[
C_{j} = \frac{456,000,000 \text{ particles}}{m_{\text{m}^3}} \cdot \frac{2340 \text{ kg/m}^3}{m_{\text{m}^3}} \cdot \frac{\pi}{6} \left(12.3 \times 10^{-6} \text{ m}\right)^3 \cdot 10^6 \text{ mg/kg}
\]

\[
C_{j} = 1039.7 \text{ mg/m}^3
\]

**C\_j = 1040 \text{ mg/m}^3 \pm 3 \text{ sig. digits}**

**Answer**