# ENV 320 – Atmospheric Aerosols

Exercise session

09.05.2025

Which of the following processes does **not** shorten aerosol lifetime in the atmosphere ?

| | | | |
|---|---|---|---|
| 0 ✗ | 0 ✗ | 0 ✗ | 0 ✓ |
| Wet deposition | Coagulation | Sedimentation | Nucleation |

Which of the following options correctly describes primary and secondary aerosols ?

0 ×

Primary = liquid ; Secondary = solid

0 ✓

Primary = directly emitted ; Secondary = formed from gases

0 ×

Primary = natural ; Secondary = anthropogenic

0 ×

Primary = form in clouds ; Secondary = form at surface

# What does the volume equivalent diameter of a particle represent ?

0 ×

Exact measured width of the particle using a microscope.

0 ✓

Diameter of a sphere with the same volume as the considered particle.

0 ×

Smallest dimension of the particle.

0 ×

Distance the particle can travel in the atmosphere.

# What does the Stokes Law describe ?

0 ×

Absroption of gases by aerosols.

0 ×

Chemical aging of particles in the atmopshere.

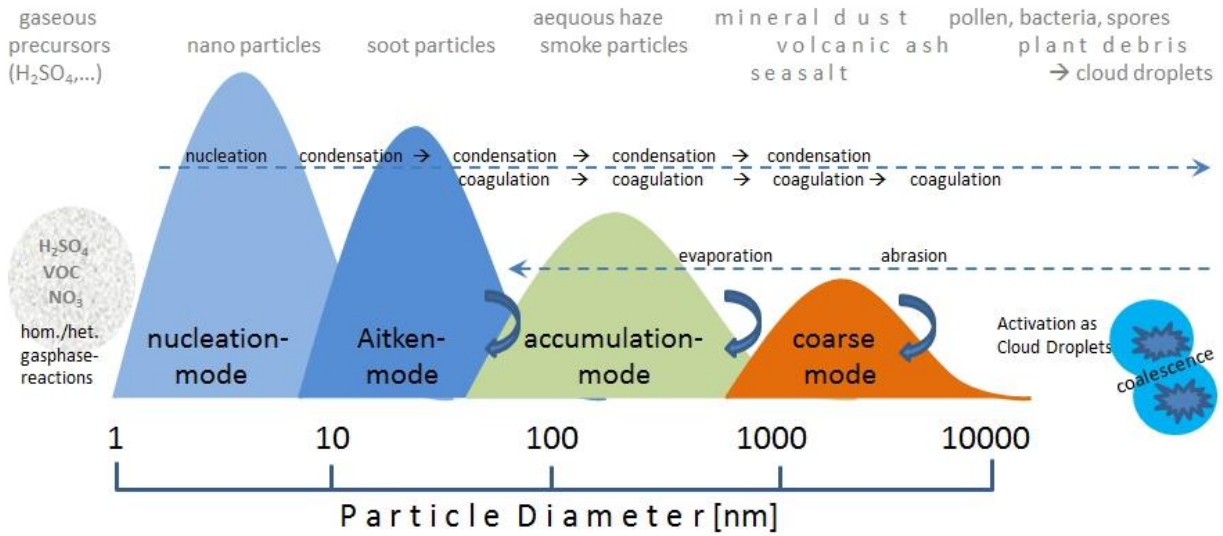
0 ✓

Movement of particles through air.

0 ×

Interaction between radiation and greenhouse gases.

# Which of the following options is used to characterize the aerosol size distribution ?




0 ×

Condensation, evaporation, coagulation, and deposition.

0 ✓

Nucleation, Aitken, accumulation, and coarse mode.

0 ×

Primary, secondary, natural, and anthropogenic.

0 ×

Solid, liquid and gaseous state.

https://www.dwd.de/EN/research/observing_atmosphere/composition_atmosphere/aerosol/cont_nav/particle_size_distribution_node.html

# What does the equilibrium vapor pressure (or saturation vapor pressure) represent ?

0 ×

Pressure exerted by the surrounding air on a liquid surface.

This is atmospheric pressure, not vapor pressure.

0 ✓

Amount of substance that can be "held" in the gas phase at equilibrium

Equilibrium (or saturation) vapor pressure refers to the pressure exerted by a vapor in equilibrium with its liquid (or solid) at a given temperature — not the *maximum pressure* a gas can reach.

0 ×

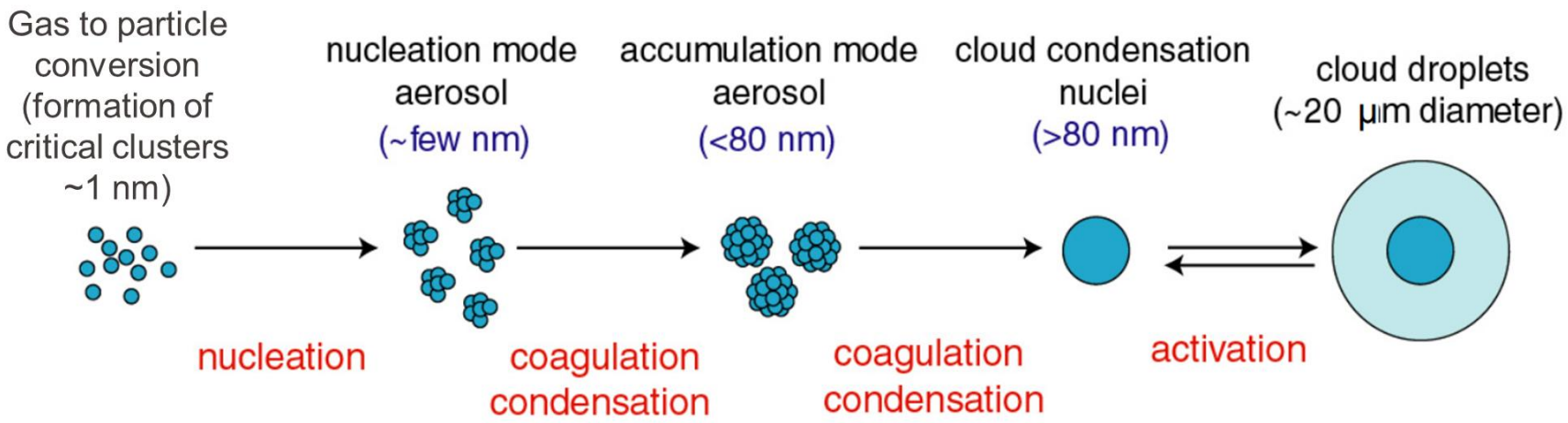
Maximum pressure a gas can reach before condensing into a solid.

Refers again to total atmospheric pressure, not the equilibrium pressure of a specific substance.

0 ×

Total pressure of all gases present in the atmosphere.

Which of the following correctly describes the sequence of processes from gas-phase to cloud droplets ?




0 ×

Activation → coagulation/condensation → removal → cluster formation

0 ✓

Cluster formation → coagulation/condensation → activation → removal

0 ×

Coagulation/condensation → cluster formation → activation → removal

0 ×

Removal → coagulation/condensation → cluster formation → activation

# What does the first law of thermodynamics state ?

0 ×

Energy can be created and destroyed, but not transformed.

0 ×

Entropy of an isolated system always decreases.

0 ✓

Conservation of energy.

0 ×

Temperature stays constant with energy input.

# What does the second law of thermodynamics state ?

0 ×

Conservation of energy.

0 ×

Total entropy of an isolated system always decreases over time.

0 ×

Heat flows from a colder object to a hotter object.

0 ✓

Total entropy of an isolated system always increases over time.

# What does the chemical potential stand for ?

0 ✓

Partial molar Gibbs energy of a substance in a mixture.

0 ×

Total energy of a system at constant temperature and pressure.

0 ×

Partial molar enthalpy of a substance in a mixture.

0 ×

Total entropy change during a chemical reaction.

# Which statement correctly describes Raoult's Law and Henry's Law ?

They apply only under specific assumptions.

0 ×

Raoult's Law is for gases, Henry's Law for liquids.

0 ×

Raoult's Law is for dilute solutions, Henry's for ideal ones.

0 ×

Both apply to all mixtures.

0 ✓

Raoult's Law is for ideal solutions, Henry's for ideal-dilute solution

Which energy barrier must be overcome for supersaturated vapors to form stable clusters during nucleation ?

0 ×

Activation energy for chemical reactions.

0 ✓

Critical Gibbs free energy barrier.

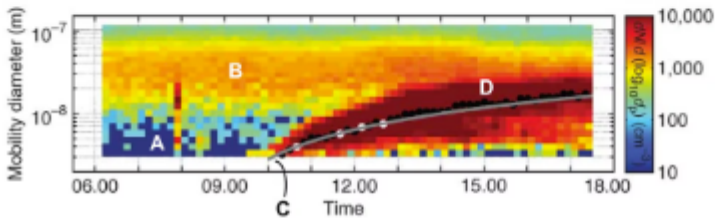
0 ×

Latent heat of condensation.

0 ×

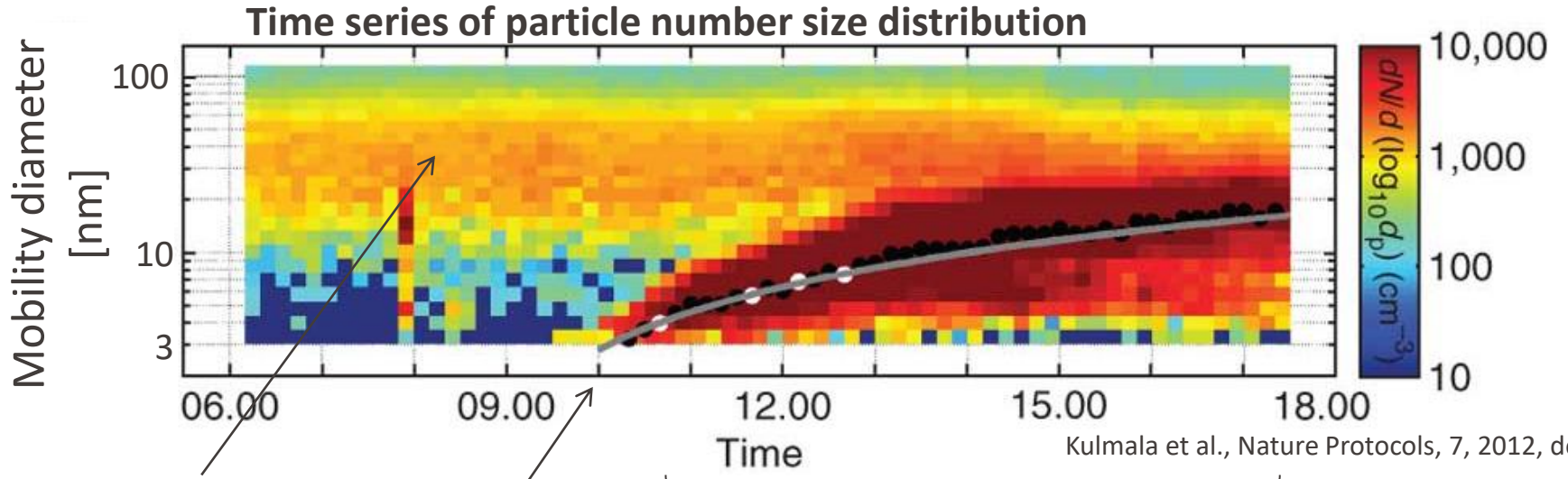
Van der Waals attraction energy.

# Where does the nucleation event happen in the plot ?




| 0 | 0 | 0 | 0 |
|---|---|---|---|
| A | B | C | D |

# «Banana-Type» Nucleation Event in the Atmosphere




Kulmala et al., Nature Protocols, 7, 2012, doi:10.1038/nprot.2012.091

background aerosol

**nucleation event**
(some species are sufficiently supersaturated to trigger new particle formation)

**growth** by condensation
(coagulation also results in growth but it is a loss in terms of particle number!)

**photochemistry** produces low volatility vapours that drive nucleation and condensation (previous lecture)

- **Nucleation events are frequently observed in the atmosphere.**
- **Secondary particles from nucleation give a substantial contribution to the total number of cloud condensation nuclei (see lectures by Thanos Nenes).**