Lightning

Electrification of Clouds (Charge Separation)

- Lightning occurs only in clouds that extend above the freezing level
- No one knows with 100% confidence how the separation of charge occurs
- There are many hypotheses as to how this may happen, but it is very difficult to run actual tests in the atmosphere to prove whether these hypothesis are true or false

Four Hypotheses

1) Liquid Surface on Hailstone

- Although we don't notice it frozen solids are often coated with a liquid surface even at temperatures well below freezing
- Hailstones are covered with this liquid surface
- This liquid surface is often only a few molecules thick
- As an ice crystal and a hailstone collide, some of the liquid water molecules on the surface of the hailstone migrate to the ice crystal
- Along with these molecules there is a transfer of positive charge from the hailstone to the ice crystal as well as a transfer of negative charge from the ice crystal to the hailstone
- The heavier hailstones(-) fall towards the ground while the lighter ice crystals(+) are blown upwards by the strong thunderstorm updrafts creating the separation of charge

2) Rubbing Method

- As a thunderstorm develops some of the smaller ice crystals grow into hailstones
- These hailstones remain suspended in the strong updrafts
- In addition small ice crystals are being blown upwards rubbing against the hailstones as they go by
- This rubbing creates an electric charge, negative on the hailstones and positive on the smaller ice crystals
- The heavier hailstones(-) fall towards the ground while the lighter ice crystals(+) are blown upwards by the strong thunderstorm updrafts creating the separation of charge

3) Falling Hail and Graupel

- Graupel and hail fall through supercooled water and ice crystals
- The hail, graupel, ice crystals and supercooled water particles initially have both Pos. **(+)** and Neg. **(-)** charge
- As supercooled water collides with a hailstone it immediately freezes onto the hailstone releasing latent heat
- The surface of the hailstone is now slightly warmer than the surrounding ice crystals
- When a warmer hailstone encounters a colder ice crystal there is a net transfer of positive ions from the warmer hailstone to the colder ice crystal
- Hail is now negatively charged **(-)**
- Ice crystals are now positively charged **(+)**
- The heavier hailstones(-) fall towards the ground while the lighter ice crystals(+) are blown upwards by the strong thunderstorm updrafts creating the separation of charge

4) Ice Splinters

- Sometimes when the colder supercooled water droplets freeze on the hailstone the new thin layer of ice breaks/splinters off into many tiny little pieces
- These splinters of ice are positively charged.
- The heavier hailstones(-) fall towards the ground while the lighter ice splinters(+) are blown upwards by the strong thunderstorm updrafts creating the separation of charge