

LIGHTNING STRIKES

Context: Climate change is making lightning strikes around the world more common and deadlier. Every year, around 24,000 people around the world are killed by such strikes; in India, lightning strikes killed 2,887 people in 2022.

- There have been petitions to declare this phenomenon a natural disaster in India so that its survivors can access institutional mechanisms for protection.
- Against this backdrop, lightning rods are important for their ability to keep lightning away from people.

What is lightning?

- Lightning is an electrical discharge between charged particles in a cloud and the ground. Objects can be classified as electrical conductors or insulators, but this depends on the electrical energy acting on the object.
- For example, the air around us is an electrical insulator: it doesn't transport electric charges. But if it is subjected to a high voltage of around 3 million V/m, its insulating properties break down and it can transport a current.
- Lightning strikes are possible because electrical charges can build up in a cloud beyond the ability of air to keep resisting their movement.
- In **India**, lightning strikes are particularly prevalent in **eastern** and **central regions**, with **Odisha** recording the **highest fatalities**.
- Triggered by **atmospheric instability** and exacerbated by the **monsoon season** and **climate change**, lightning strikes are a significant **natural hazard**

What is a lightning rod?

- While a lightning strike occurs between a cloud and an object on or near the ground, it takes the path of least resistance, which means it moves towards the closest object with the highest electric potential. "The reason lightning strikes the rod has to do with its shape.
- Lightning rods are pointy and pointed things create stronger electric fields near them. "It's like saying the flow of water speeds up near a nozzle.
- The electric field is the force that acts on molecules of air, so it becomes strongest near the lightning rod.
- This force ionises the air near the rod first and provides a route for the current to flow."

- Think of a lightning strike as the extended hand of someone who wants to be pulled out of a pool.
- If there are many hands offering to help, the lightning's hand will reach for the strongest one.
- A lightning rod is an electrical conductor that takes advantage of this fact with one addition: engineers install it on building-tops in a way that it's the first hand the lightning encounters on its way down.
- This is also why it's risky to stand under trees in an otherwise open field, like a farm.

Where does the current in a lightning rod go?

- Heat energy always flows from a warmer object to a cooler object. Liquid water flows from a place with a higher gravitational potential to a lower one.
- Similarly, an electric current flows from a place with higher electric potential to a place with lower electric potential.
- The earth, an abundant source of lower electric potential. The lightning rod is connected to a wire that drops through the length of the building into the ground, where it dissipates its electric charges into its surroundings.
- The idea here is that electrifying the earth will need virtually infinite amount of charges, so it's treated as a bucket that will never fill up.
- However, some parts of the bucket may still be better at receiving the charges than others.
- If a strike induces a large current in a grid-connected electrical system, engineers connect the wire to a line that allows only high currents, thus diverting them away from devices that can handle only low currents. Such setups are called **lightning arresters**.

Can lightning evade a lightning rod?

- A lightning strike may evade a lightning rod if the rod is installed at the wrong height or angle or too close to another structure, isn't properly grounded, if there are multiple thunderstorms in an area, if it has a flawed design, or if it has become misshapen and/or corroded due to lack of maintenance.
- It can also fail if an electrical discharge ascends from the ground to meet a descending strike, risking bypassing the rod, or if a strike is more attracted to the side of a tall building than to the top.
- Over the years engineers have devised new incentives for lightning to prefer a lightning rod over other structures nearby.
- Among others, they make sure a lightning rod is available for lightning to strike within the minimum distance the strike travels in each step it takes towards the ground.

What dangers does a lightning rod pose?

- The lightning rod and the components connected to it are designed to carry a lightning strike into the ground. This means catching the strike and safely transporting it.
- If the wire bends in a U shape at any point, the two arms of the U should be far apart to prevent the current from arcing across and shorting the conductor.
- The charges should also not be able to arc through any other objects nearby. Engineers also bury the grounding wire in a part of the crust with higher electrical conductivity so that the wire dissipates charges faster.

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