

Question 11.

Read the following passage and answer the accompanying questions.

Benjamin Franklin designed the lightning conductor. This is a thick copper strip running up the outside of a tall building. The upper end of the strip terminates in one or more sharp spikes above the highest point of the building. The lower end is connected to a metal plate buried in moist earth. The lightning conductor protects a building from being damaged by lightning in a number of ways.

During a thunderstorm, the value of the electric field strength in the air can be very high near a pointed lightning conductor. If the value is high enough, ions, which are drawn towards the conductor, will receive such large accelerations that, by collision with air molecules, they will produce vast additional numbers of ions. Therefore the air is made much more conducting and this facilitates a flow of current between the air and the ground. Thus, charged clouds become neutralised and lightning strikes are prevented. Alternatively, in the event of the cloud suddenly discharging, the lightning strike will be conducted through the copper strip, thus protecting the building from possible catastrophic consequences.

Raised umbrellas and golf clubs are not to be recommended during thunderstorms for obvious reasons.

On high voltage electrical equipment, pointed or roughly-cut surfaces should be avoided.

(Adapted from “Physics – a teacher’s handbook”, Dept. of Education and Science.)

- (a) Why is a lightning conductor made of copper?
- (b) What is meant by electric field strength?
- (c) Why do the ions near the lightning conductor accelerate?
- (d) How does the presence of ions in the air cause the air to be more conducting?
- (e) How do the charged clouds become neutralised?
- (f) What are the two ways in which a lightning conductor prevents a building from being damaged by lightning?
- (g) Why are raised umbrellas and golf clubs not recommended during thunderstorms?
- (h) Explain why pointed surfaces should be avoided when using high voltage electrical equipment.

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- (a) Why is a lightning conductor made of copper?

As copper is a good conductor of electricity.

- (b) What is meant by electric field strength?

At any particular point in an electric field, it is the force experienced per unit positive charge at that point.
 $E = F/Q$. It is measured in NC^{-1} or more commonly Vm^{-1} .

- (c) Why do the ions near the lightning conductor accelerate?

Because the electric field strength near the point of the conductor is great and hence the charged particles experience a large force

- (d) How does the presence of ions in the air cause the air to be more conducting?

Because they are mobile and can carry electric charge

- (e) How do the charged clouds become neutralised?

By the flow of charge through the air and conductor to (or from) earth.

- (f) What are the two ways in which a lightning conductor prevents a building from being damaged by lightning?

The lightning conductor neutralize some of the charge on the cloud as it passes, and if it does discharge, it offers a low resistance pathway through which the charge may pass in preference to passing through the structure itself.

(g) Why are raised umbrellas and golf clubs not recommended during thunderstorms?

They act as conductors (usually made of metal)

(h) Explain why pointed surfaces should be avoided when using high voltage electrical equipment.

To avoid the point effect, i.e., so as not to increase the risk of electrical discharges from the equipment.