Lightning

Nature of Lightning

Lightning is a natural electric spark occurring on a large scale during thunderstorms. It is caused by the accumulation of electric charges in clouds, leading to a sudden discharge of electricity between clouds or between clouds and the earth.

Historical Understanding

Ancient Greeks observed static electricity phenomena such as amber attracting light objects when rubbed. Benjamin Franklin demonstrated in 1752 that lightning and static sparks are similar phenomena involving electric charges.

Charging by Rubbing

Objects can acquire electric charge by rubbing with other materials, a process called charging by friction. For example, rubbing a plastic comb with dry hair transfers electrons, charging the comb.

Types of Charges and Their Interaction

There are two types of electric charges: positive and negative. Like charges repel each other, while unlike charges attract. This is demonstrated by experiments with charged balloons and pen refills.

Transfer of Charge

Electric charge can be transferred from one object to another through conductors. An electroscope is a device used to detect electric charge by observing the repulsion of metal leaves when charged.

The Story of Lightning

During thunderstorms, air currents cause separation of charges in clouds, with positive charges accumulating at the top and negative charges at the bottom. The ground beneath becomes positively charged. When the potential difference becomes large, an electric discharge occurs as lightning.

Lightning Safety

During thunderstorms, it is important to seek shelter indoors or inside vehicles with windows closed. Avoid open fields, tall trees, metal objects, and open vehicles. If caught outside, crouch low with feet together and head covered to minimize risk.

Lightning Conductors

Lightning conductors are metal rods installed on buildings to safely channel lightning current to the ground, protecting structures from damage.

Solved Examples

Example 1: Explain why two balloons rubbed with wool repel each other when hung close together.

Solution: Rubbing the balloons transfers electrons, giving both balloons the same type of charge (negative). Like charges repel, so the balloons push away from each other.

Example 2: Describe how an electroscope detects electric charge.

Solution: When a charged object touches the metal rod of the electroscope, charge transfers to the metal leaves. Since both leaves acquire the same charge, they repel and spread apart, indicating the presence of charge.

Practice Set

- **Level 1:** What causes lightning during a thunderstorm?
- **Level 2:** Why do like charges repel and unlike charges attract? Explain with examples.
- **Level 3:** Describe the working of a lightning conductor and how it protects buildings.

Answer Key

Level 1: Lightning is caused by the accumulation of opposite electric charges in clouds and the ground, leading to an electric discharge.

Level 2: Like charges repel because they exert forces pushing each other away, while unlike charges attract due to opposite electric forces. For example, two negatively charged balloons repel, but a negatively charged balloon and a positively charged object attract.

Level 3: A lightning conductor is a metal rod fixed on a building connected to the ground by a wire. It provides a safe path for lightning current to flow into the earth, preventing

damage to the building.

Earthquakes

Definition and Effects

An earthquake is a sudden shaking of the earth caused by disturbances deep inside the earth's crust. It can cause damage to buildings, bridges, and loss of life.

Causes of Earthquakes

Earthquakes occur due to the movement of earth's plates. The earth's crust is divided into plates that move and interact, causing disturbances at their boundaries.

Structure of the Earth

The earth consists of layers: crust, mantle, outer core, and inner core. The crust is fragmented into plates that move over the mantle.

Plate Movements

Plates can collide, causing one to move under another (subduction), or slide past each other. These movements cause earthquakes.

Measuring Earthquakes

Earthquakes are measured on the Richter scale, which quantifies their magnitude. The Richter scale is logarithmic; an increase of 2 in magnitude means 1000 times more energy released.

Seismic Waves and Seismograph

Earthquakes produce seismic waves recorded by a seismograph, which uses a pendulum to detect ground vibrations and records them on paper.

Protection Against Earthquakes

Buildings in seismic zones should be designed to withstand tremors. During an earthquake, take shelter under sturdy furniture or in open areas away from buildings.

Solved Examples

Example 1: What causes the shaking during an earthquake?

Solution: The shaking is caused by seismic waves generated by sudden movements of earth's plates at faults beneath the surface.

Example 2: How does a seismograph record an earthquake?

Solution: The seismograph's pendulum remains stationary due to inertia while the ground moves, causing a pen attached to the pendulum to trace vibrations on rotating paper, recording seismic waves.

Practice Set

- **Level 1:** What is the focus and epicenter of an earthquake?
- **Level 2:** Explain why the Richter scale is logarithmic and its significance.
- **Level 3:** Describe measures to make buildings earthquake-resistant.

Answer Key

Level 1: The focus is the point inside the earth where the earthquake starts; the epicenter is the point on the surface directly above the focus.

Level 2: The Richter scale is logarithmic because each increase of 1 represents a tenfold increase in amplitude of seismic waves and about 31.6 times more energy released, allowing a wide range of earthquake magnitudes to be measured.

Level 3: Earthquake-resistant buildings use flexible materials, simple designs, light roofs, fixed shelves, and fire-fighting equipment to withstand tremors and reduce damage.

Quick Reference Table

Common Mistakes and Misconceptions

Glossary