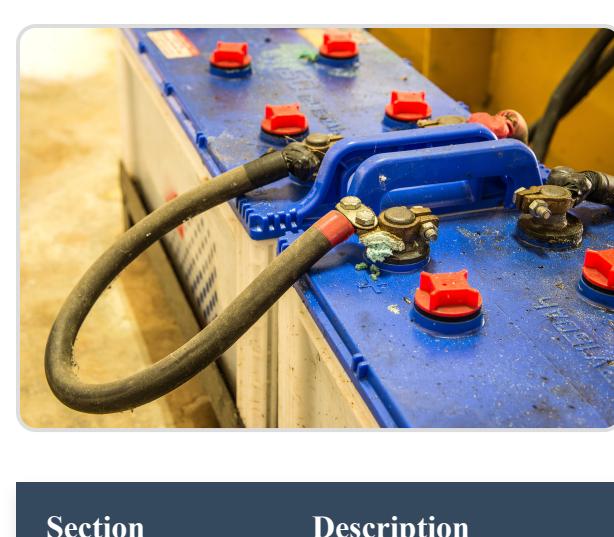
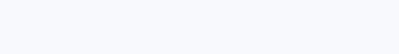


Welcome to My GeeksforGeeks

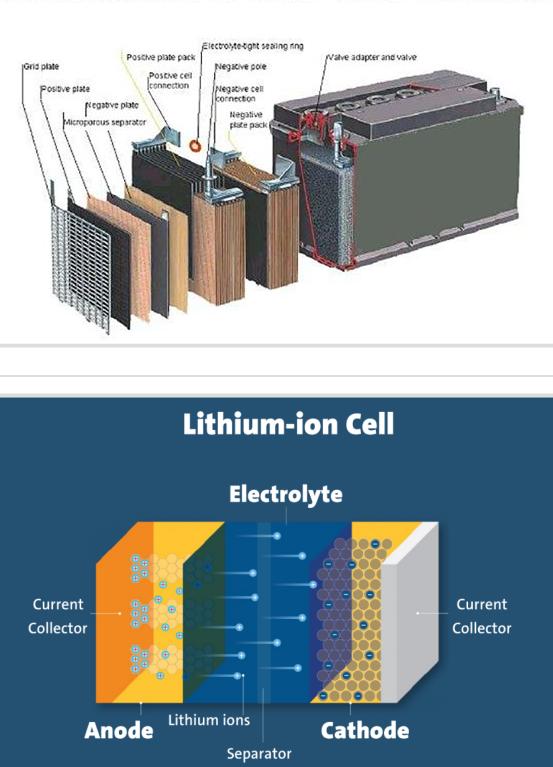
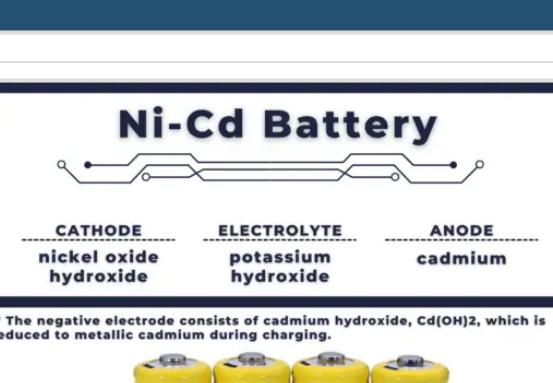
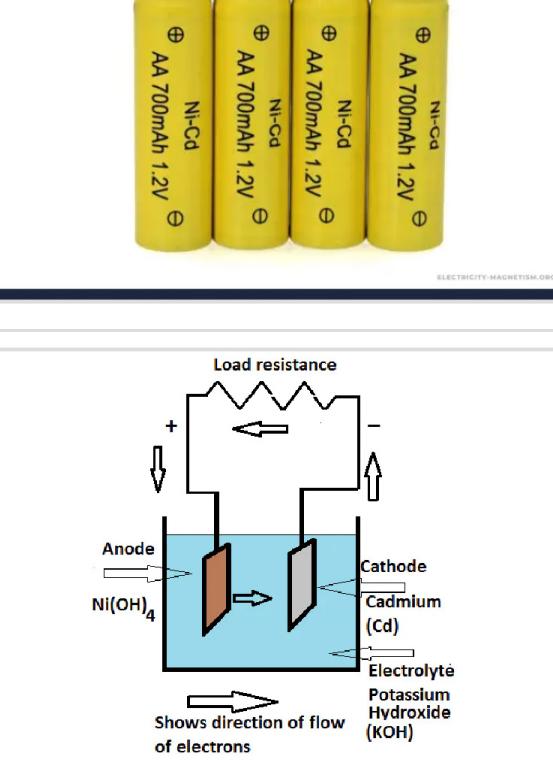
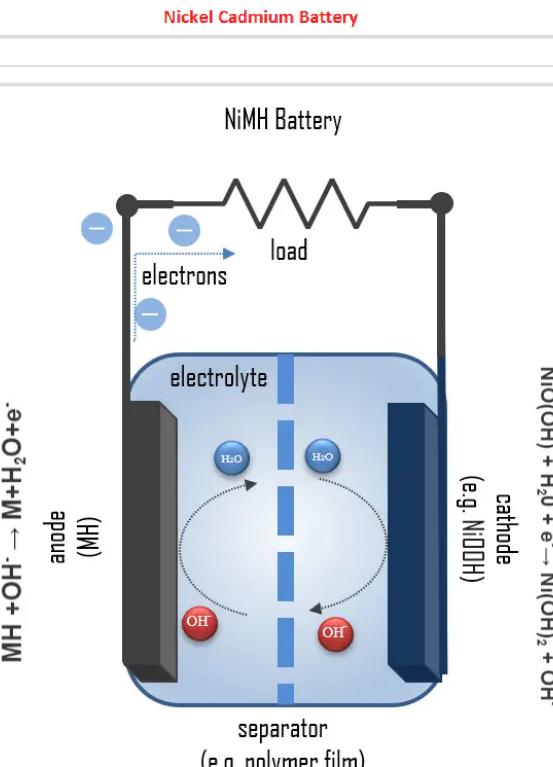
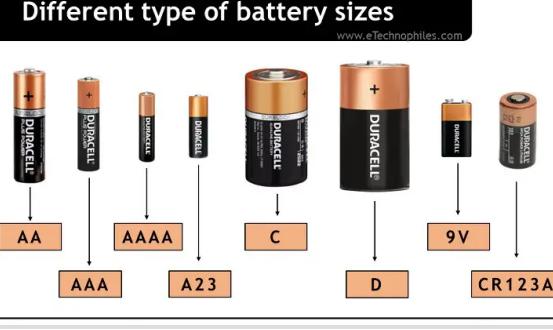
Lead-Acid Batteries



Section	Description
Definition of Lead-Acid Batteries	Lead-acid batteries are a type of rechargeable battery that uses lead dioxide as the positive electrode, sponge lead as the negative electrode, and a sulfuric acid solution as the electrolyte. Invented in 1859, they are one of the oldest types of batteries and are commonly used in automotive, backup power, and industrial applications due to their reliable performance and high power density.
Benefits of Lead-Acid Batteries	<ul style="list-style-type: none">Cost-Effectiveness: Affordable, widely accessible, and suitable for various applications.High Reliability and Robustness: Durable, performs well under environmental variations, and withstands misuse.High Power Output: Provides high surge current for energy-demanding applications like vehicle starters.Ease of Recycling: Highly recyclable, with about 98% of components reusable, reducing environmental impact.Established Technology: Mature, widely accepted with strong infrastructure for manufacturing and recycling.
How Lead-Acid Batteries Work	Lead-acid batteries generate electrical energy through an electrochemical reaction between lead dioxide (PbO_2) on the positive plate and sponge lead (Pb) on the negative plate in the presence of a sulfuric acid (H_2SO_4) electrolyte. During discharge, lead dioxide and sponge lead react with sulfuric acid to form lead sulfate ($PbSO_4$) and water, releasing electrons in the process. During charging, the reaction reverses to restore the original materials and recharge the battery.
Diagram and Structure	 Diagram showing the internal structure: positive plate, negative plate, and sulfuric acid electrolyte.
Applications	<ul style="list-style-type: none">Automotive Batteries: Powers starter motors, lights, and electrical systems in vehicles.Uninterruptible Power Supplies (UPS): Backup power for servers, computers, and critical systems.Renewable Energy Storage: Used in solar and wind power systems to store energy.Industrial Applications: Powers forklifts, golf carts, and marine equipment due to robustness.
Advantages Over Other Battery Types	Lead-acid batteries are cost-effective and easily recyclable, providing reliable performance in high-drain applications. They are ideal for situations where initial cost is more critical than energy density or weight.
Limitations	<ul style="list-style-type: none">Lower Energy Density: Heavier and bulkier compared to other battery types, making them less suitable for applications needing high energy-to-weight ratios.Limited Cycle Life: Shorter lifespan, with periodic maintenance required, such as adding distilled water in unsealed batteries.Environmental Hazards: Contains toxic materials, and improper disposal can harm the environment despite high recyclability.

Battery Types and Their Characteristics

Type	Definition	Construction	Operation Principle	Components	Applications
Lead-Acid Batteries	Rechargeable battery with lead plates and sulfuric acid.	Consists of lead plates and sulfuric acid in a plastic case.	Energy stored via chemical reaction, available on demand.	Lead, lead dioxide, sulfuric acid.	Used in automotive, UPS, and solar applications.
Type	Definition	Construction	Operation Principle	Components	Applications
Lithium-Ion Batteries	Rechargeable batteries where lithium ions move between electrodes during discharge and charge.	Cathode (lithium metal oxide), anode (carbon), electrolyte, separator.	Lithium ions move through an organic solvent electrolyte between cathode and anode.	Lithium metal oxides, carbon/graphite, organic solvent.	Portable electronics, electric vehicles, renewable energy storage.
Nickel-Cadmium Batteries	Rechargeable batteries using nickel oxide hydroxide and metallic cadmium.	Nickel and cadmium electrodes in an alkaline electrolyte.	Oxidation-reduction reactions between cadmium and nickel compounds.	Nickel oxide hydroxide, cadmium, alkaline electrolyte.	Power tools, photography equipment, emergency lighting.
Nickel-Metal Hydride Batteries	Similar to nickel-cadmium but with a hydrogen-absorbing alloy replacing cadmium.	Metal hydride negative electrode, nickel hydroxide positive electrode.	Hydrogen ions move between electrodes, facilitating charge and discharge.	Nickel hydroxide, metal hydride alloy, alkaline electrolyte.	Hybrid vehicles, high-drain electronics, digital cameras.
Alkaline Batteries	Primary batteries dependent on the reaction between zinc and manganese dioxide.	Zinc powder anode, manganese dioxide cathode, alkaline electrolyte.	Electrochemical reaction of zinc with manganese dioxide produces energy.	Zinc, manganese dioxide, alkaline potassium hydroxide.	Remote controls, flashlights, toys, and portable electronics.

Image	Description
	This image illustrates the basic knowledge and classification of lead-acid batteries.
	This image shows the structure of a lithium-ion cell, highlighting its components.
	This image provides a composition breakdown of a nickel-cadmium (Ni-Cd) battery.
	This image details the principle structure and material composition of a nickel-cadmium battery.
	This image explains the principle of operation for a nickel-metal hydride (NiMH) battery.
	This image highlights the design and structure of alkaline batteries.
	This image compares various battery sizes and their typical applications.

ELECTROLYTIC VS CERAMIC CAPACITOR FILE ENDS Here