PHYSICS PROJECT WORK

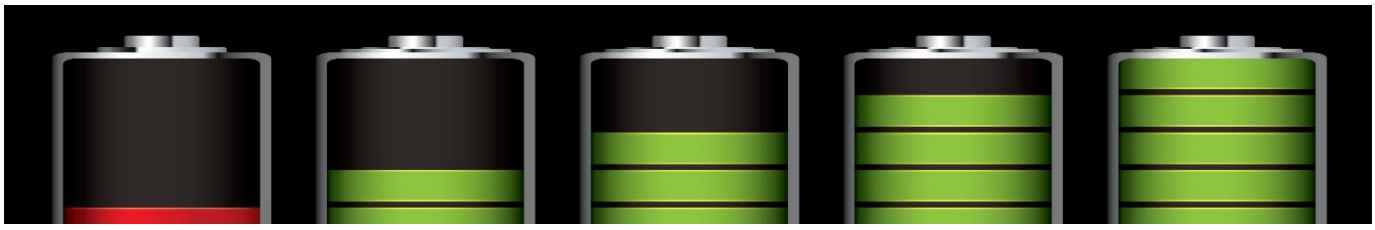
NAME OF THE STUDENT : SHAIK IMRAN

CLASS : III BSC(MPC)

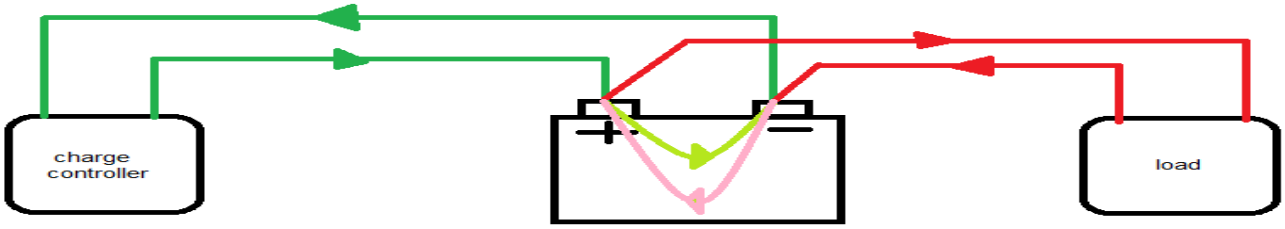
NAME OF PROJECT : TYPES OF BATTERIES

COLLEGE NAME : S.V.C.R. GOVT DEGREE COLLEGE, PALAMANER

GUIDED BY : M. SURYA SHEKAR REDDY(MSc, PhD).



ALESSANDRO VOLTA



WHAT IS A BATTERY?

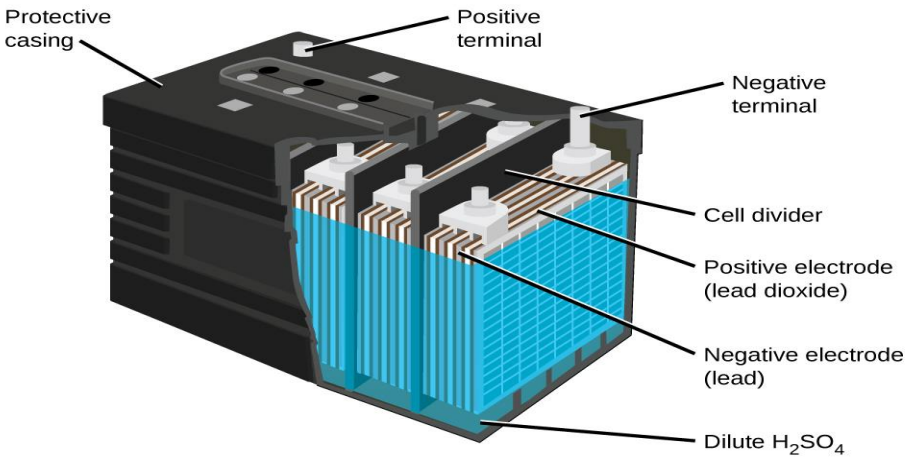
A **battery** is an energy source consisting of one or more electrochemical cells and terminals on both ends called an anode (-) and a cathode (+). Electrochemical cells transform chemical energy into electrical energy. Inside the battery is an electrolyte, often consisting of soluble salts or acids, it serves as a conductive medium, allowing the electric charge to travel through the battery.

(OR)

A **battery** is a device that converts chemical energy contained within its active materials directly into electric energy by means of an *electrochemical oxidation-reduction* (redox) reaction

There are three parts to a battery:

- Cathode, the negative side,
- Anode, the positive side, and
- Electrolyte, the chemical which reacts with both sides



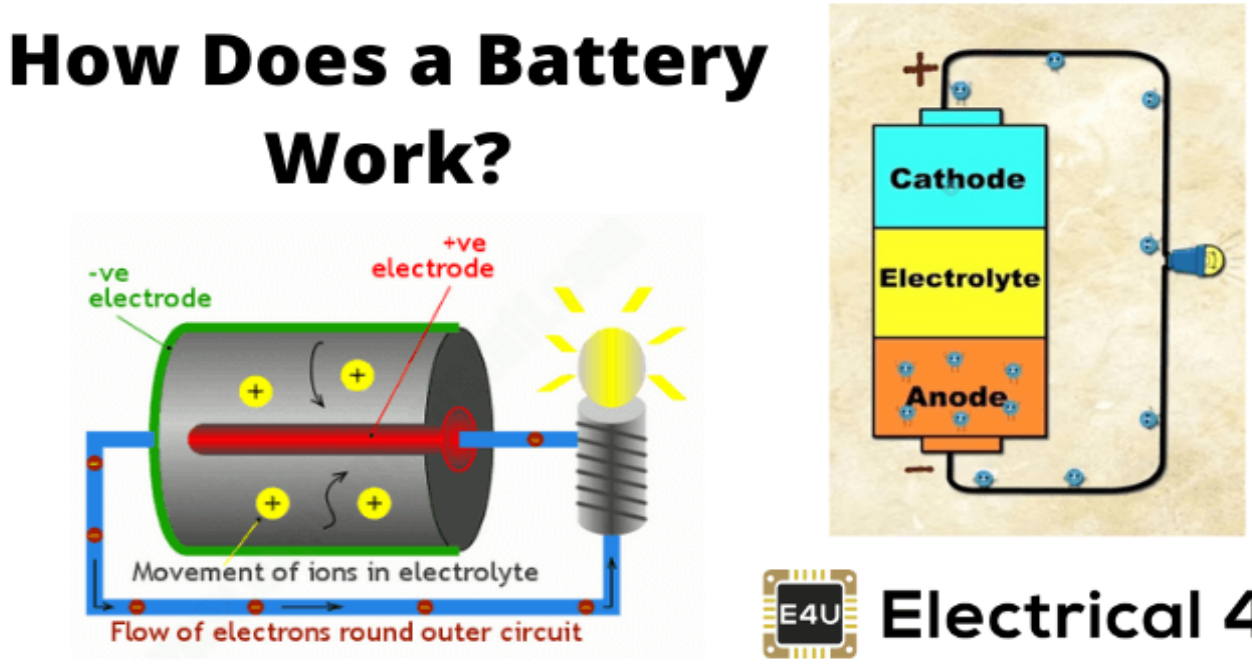
Working Principle of Battery

A battery works on the oxidation and reduction reaction of an electrolyte with metals. When two dissimilar metallic substances, called electrode, are placed in a diluted electrolyte, oxidation and reduction reaction take place in the electrodes respectively depending upon the electron affinity of the metal of the electrodes. As a result of the oxidation reaction, one electrode gets negatively charged called cathode and due to the reduction reaction, another electrode gets positively charged called anode.

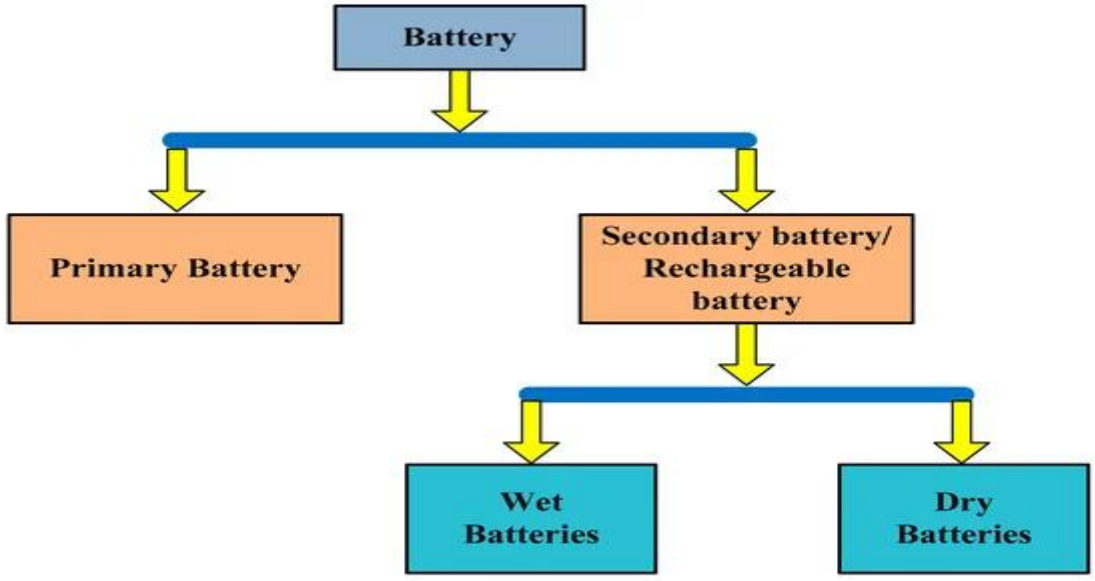
The cathode forms the negative terminal whereas anode forms the positive terminal of a battery. To understand the **basic principle of battery** properly, first, we should have some basic concept of electrolytes and electrons affinity. Actually, when two dissimilar metals are immersed in an electrolyte, there will be a potential difference produced between these metals.

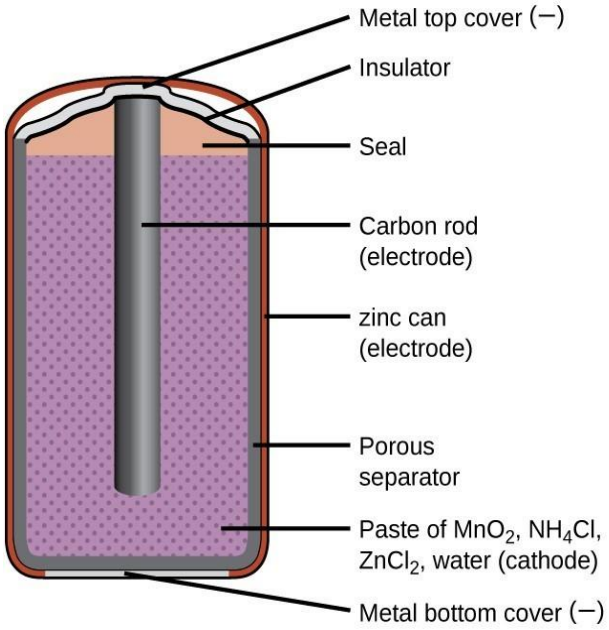
This difference in electron concentration causes an electrical potential difference developed between the metals. This electrical potential difference or emf can be utilized as a source of voltage in any electronics or electrical circuit. This is a general and basic **principle of battery** and this is **how a battery works**.

All batteries cells are based only on this basic principle. Let's discuss one by one. As we said earlier, Alessandro Volta developed the first battery cell, and this cell is popularly known as the simple voltaic cell. This type of simple cell can be created very easily. Take one container and fill it with diluted sulfuric acid as the electrolyte. Now we immerse one zinc and one copper rod in the solution and we connect them externally by an electric load. Now your simple voltaic cell is completed. Current will start flowing through the external load.



TYPES OF BATTERIES





PRIMARY BATTERIES

Primary batteries can be charged just once. These batteries become worthless when they are entirely depleted and must be thrown. The most common reason primary batteries can't be recharged is that the electrochemical reaction that occurs inside them is irreversible. It's worth remembering that these primary batteries are also known as use-and-throw batteries.

(or)

The simplest definition of a Primary Battery refers to a voltaic battery or cell which is used once and then discarded. Though recharging is not possible in primary batteries, these batteries have an additional advantage of less cost per battery and convenience. this are single time used batteries.

Non-rechargeable batteries come with a wide range of advantages which make these devices the number one choice for most users. First of all, primary batteries cost super low as compared to other smart batteries. Besides affordability, these batteries are easy, simple, and convenient to the extent that any novice can use them without any trouble.

Types of primary batteries:

There are a few basic types of primary batteries that are discussed in detail below

Alkaline Batteries:

This is one of the most basic types of primary battery that gets its energy from the chemical reaction between zinc metal and manganese dioxide. As compared to other batteries like a zinc-carbon battery of the zinc chloride, alkaline batteries possess a greater energy density and longer lifespan.

Instead of the acidic ammonium chloride or zinc chloride, the battery consists of an alkaline electrolyte of potassium hydroxide and due to this property it is named “alkaline batteries”.

Alkaline batteries consist of a steady voltage which provides better energy density and leakage resistance, unlike carbon zinc batteries. These batteries get this characteristic mainly due to the presence of manganese dioxide anode as it is better and denser and avoid other components to take up a lot of unnecessary space.

The primary users of the alkaline battery are situated in the regions of North America and Europe. However, Latin America and the Asia Pacific hold a higher probability of growth in the alkaline battery market. That’s because these regions are moving from the use of

carbon zinc batteries to alkaline batteries. When it comes to the Middle East and Africa, both these regions are seeing a rising trend of using these batteries.

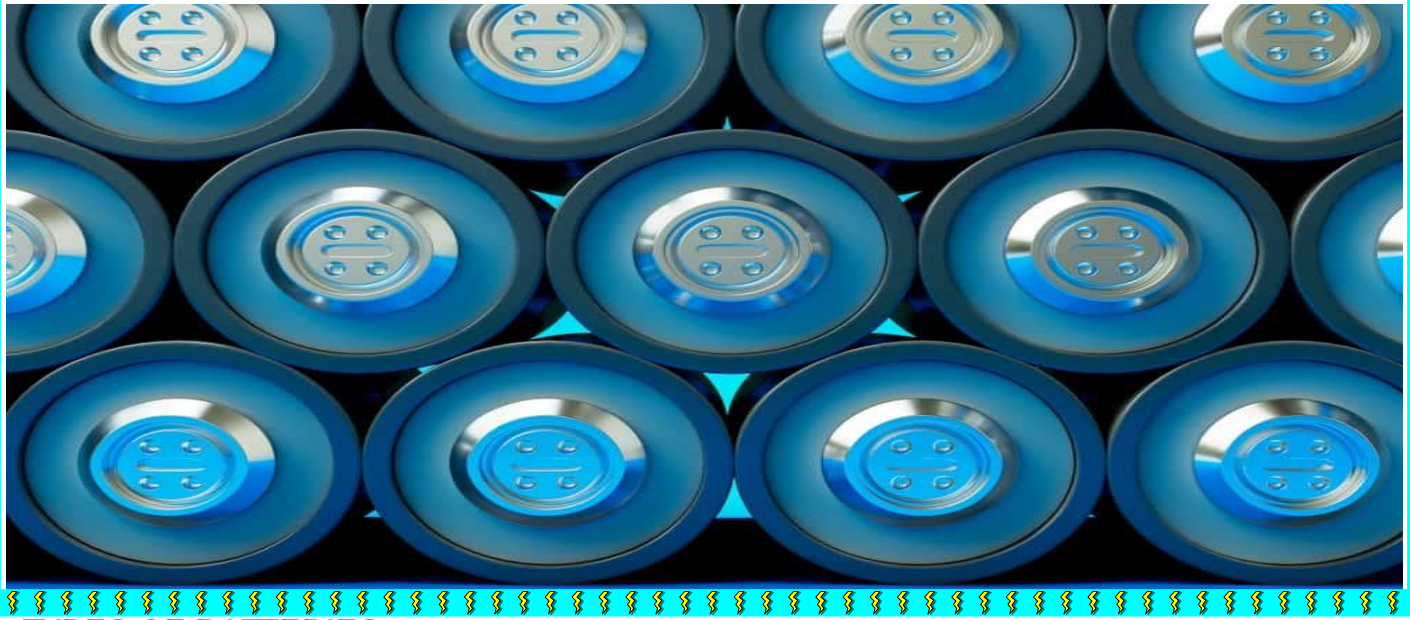
You can find alkaline batteries in numerous size forms such as AAA, AA, C, D, 9V etc. C, D, and 9V are ideally used for high-drain devices while AA and AAA are used for low-drain applications.

Lithium Batterie:

Also known as lithium rechargeable batteries, these primary batteries consist of metallic lithium as an anode. They are widely popular today, as you can use them to power devices such as MP3 players, car locks, thermometers, laser pointers, and hearing aids.

What sets them apart from other types of batteries is they provide high charge density and high cost per unit. Lithium cells are known for producing voltages from 1.5 V to 3.7 V, depending on their model and chemical compounds used.

However, lithium batteries should not be confused with lithium-ion batteries as they are rechargeable, storage battery used in devices like laptops, cell phones, PDAs, and iPods



Mercury:

Also known as mercuric oxide battery or mercury cell, the mercury battery is a non-rechargeable electrochemical battery that can be used up to 10 years. This miniature-sized battery uses a chemical reaction between zinc electrodes and mercuric oxide in an alkaline electrolyte.

Owing to their long lifespan and steady voltage output, these batteries are the most common type of battery in the 20th century. They are popularly used in portable electronic devices such as watches, calculators, toys, cameras, digital thermometer etc.

Unlike the other two batteries that are discussed above, mercury cells come in a button-like shape and size which make these batteries super convenient and easy to carry around.

Zinc Air Battery:

Also called zinc-air fuel cells, zinc air batteries are metal air devices that function with the combination of oxygen and oxidizing zinc. These batteries possess high energy density and aren't costly to produce. You can get these batteries, in various sizes, at quite an affordable price range.

Zinc air fuel cells comprises an anode that is made up of granulated powder and electrolyte. The electrolyte acts as a gelling agent that helps maintain the contact between the zinc particles and electrolyte. Secondly, these batteries also contain a cathode that helps oxygen to come in contact with the other chemical compound so that the reaction can take place.

The common applications of zinc air fuel cells include watches, torch lights, remote control, film cameras, hearing aids etc. Depending on the size of the device, you can choose the zinc air battery accordingly.

Secondary Batteries

Also referred to as rechargeable batteries, secondary batteries come with electrochemical cells whose chemical reactions can easily be reversed by applying some amount of voltage in an opposite direction.

Unlike primary batteries, secondary cells can be recharged and made to be used again. Typically, these cells are used in high-drain appliances or in situations that may be too costly or impractical. Some of the uses of secondary batteries include mobile phones, MP3 players, computer, telephone exchanges, wristwatches, hearing aids etc.

Following are the types of secondary batteries that are widely used today:

Lead Acid Gel:

Also known as “gel cells”, the lead acid gel battery is a VRLA battery (which stands for valve-regulated lead-acid battery) with a gel-like electrolyte. This gel-like mass is produced through a mixture of sulfuric acid with fumed silica. The gel cell is often confused with AGM styled cells as in both of them the electrolyte is suspended. However, unlike AGM cells, the gel cell has silica that makes the electrolyte stiff. The advantage of gel-based batteries over other kinds of batteries is that they last longer, especially in hot weather. Bear in mind that these are the most sensitive batteries as they can result in an adverse reaction if they are overly charged. Also, if the wrong battery charger is used for

powering up lead acid cells, then the device may poorly perform or fail entirely. The absorption voltage range from 14.0 to 14.2 volts. Gel cells are not as common as other batteries like AGM, but they are popularly used in wheelchairs, trolling motors, and RV cycles.

Lithium-Ion Battery:

Lithium-ion batteries are extremely popular these days as they are used for charging or recharging popular gadgets like PDAs, cell phones, iPods, and laptops. Besides the fact that they help charge devices we can't live without, these batteries are considered to be the most light-weight and energetic batteries available on the market.

These batteries are composed of super airy lithium and carbon which is why they are lightweight in nature. Lithium also has highly-reactive energy which means that li-ion batteries can store an excessive amount of energy in its atomic bonds.

Moreover, lithium-ion batteries lack the memory effect. This means that you won't have to discharge them first to recharge them as it is with some other batteries. Above all, these cells are able to pack 5% of its charge every month as compared to a 20% loss witnessed in NiMH batteries.

Nickel Cadmium (NiCd) Battery:

This is the type of rechargeable battery that uses metallic cadmium and nickel oxide hydroxide as their source of electrodes. To make these cells work, they need to be kept within +60 degrees centigrade all the way down to minus 20 degrees centigrade.

Choosing the right separator like polypropylene or nylon and the electrolyte such as LiOH, NaOH, and KOH is also of utmost importance for these batteries to work efficiently. These constituents keep the voltage conditions of NiCd battery intact, especially in cases like high current discharge.

If misused or mishandled, these batteries can result in a dangerously high pressure that can damage the device altogether. To avoid such an occurrence, these cells comprise a reversible safety valve. The best advantage of nickel cadmium cells is that they remain durable for a really long time

Nickel Metal Hydride Battery:

With an abbreviation NiMH or Ni-MH, a nickel metal hydride battery offers a plethora of advantages over other rechargeable batteries. First of all, nickel metal hydride batteries are a fast-working battery that can work for a really long time without getting stressed out.

Even if abused, these batteries can provide good load performance and pretty long shelf life. These batteries require low maintenance and can be stored in their state-of-discharge. Despite offering a wide array of benefits, these batteries are economical and can be invested in different sizes, shapes, and performances.

However, the battery comes with certain limitations. For example, as compared to newer battery systems, these batteries emit low energy. These batteries also demand self-discharge, even after their storage. The worst of all is that cadmium is a dangerous metal which means that the battery needs to be used with care or else can create quite destruction.

Industrial Batteries:

As the name implies, these batteries are specially designed for industrial purposes. They are heavy, consume more energy, and provide high-voracity output to an industry.

The main application of these batteries is powering heavy-duty machinery, railroads, and backup power systems for utilities and telecommunications. Following are some common types of industrial batteries used today:

Absolyte Battery:

This is the kind of industrial battery that boasts a valve-regulated lead-acid (VRLA) design. As compared to other kinds of industrial batteries, absolyte batteries are safer as they inhibit the release of harmful hydrogen gas and acid leakage. This battery comes in a strikingly modern design. For instance, it consists of a jar to cover heat seal, an excellent separator compression, a modular steel tray etc.

You can use these batteries for telecommunications, energy systems, power storage, railroad signal and communication, switchgear and photovoltaics.

Nickel Iron Battery:

The nickel-iron battery is another industrial battery consisting of nickel (III), oxide-hydroxide positive plates, and iron negative plates. In addition to these, the heavy-voltage battery consists of an electrolyte of potassium hydroxide.

These batteries tend to have an amazing life cycle and a varied range of application. Initially, it was used in mining trains and railways. However, today, it has a completely new field of application as it is used for moving and charging electric vehicles.

Steel Case:

These are reliable and supremely powerful industrial batteries, used for a variety of applications – lifting trucks and forklifts.

To identify these batteries, you must know that they are heavier than any other type of industrial battery, weighing from a few hundred kilograms to all the way to thousands of kilograms.

Steel case batteries are also available in their scrape form which means that they can be recycled and used again. Most scrap yards are willing to accept them but it is likely for them to not accept other kinds of batteries.

Flooded Lead Acid Battery:

Flooded lead acid batteries are known for their use of solar energy and are used in many stand-alone energy systems. They enjoy a relatively long lifespan and cheap per amp-hour; but in order to make the most of these advantages, these batteries need regular maintenance including cleaning and watering their internal components.

Some common examples of flooded lead acid batteries used only in solar and wind electric systems are 2 volt industrial cells, 6 volt L-16's, and 6 volt golf-cart batteries.

Vehicle Batteries:

As the name gives away, vehicle batteries are used in vehicles like motor cars, trucks, bikes etc. These batteries provide electrical current to an automobile's engine to start it up.

the engine begins to run, the car is powered by the alternator – a car's internal feature that helps charge the battery of the vehicle.

Following are some popular types of vehicle batteries that you must know about:

Hybrid Automotive:

A hybrid car battery is like any other battery, only that it is rechargeable and has enough solution to make the vehicle running for miles.

Hybrid batteries consist of two electrodes that help receive and emit an electric charge. These electrodes are present in an ion-based solution known as an electrolyte. The electrodes are separated by a separator to avoid any occurrence of a short circuit. An on-off switch connected to your phone or laptop helps the cell's electrodes to produce power, resulting in an electrochemical reaction.

Lead Acid Battery:

The lead-acid battery, invented by Gaston Plante (a French physicist) in 1859, is one of the oldest yet the most widely used battery in the world. It is the kind of automotive vehicle that uses sponge lead and lead peroxide for converting the chemical energy into electrical power.

While it is a common vehicle battery, it is also commonly used on various power stations and substations due to its excellent voltage capacity and lower costs.

What helps keep the chemical energy and electrical energy stored in the battery are the two battery parts – container and plate. The container of the lead battery is made up of glass, lead, ebonite, or hard rubber which helps prevent the discharging of electrolyte. On the other hand, the plate of the lead acid battery is designed from the grid which allows a uniform distribution of current. Without the equal distribution, the electric current may seep out and affect the battery.

s

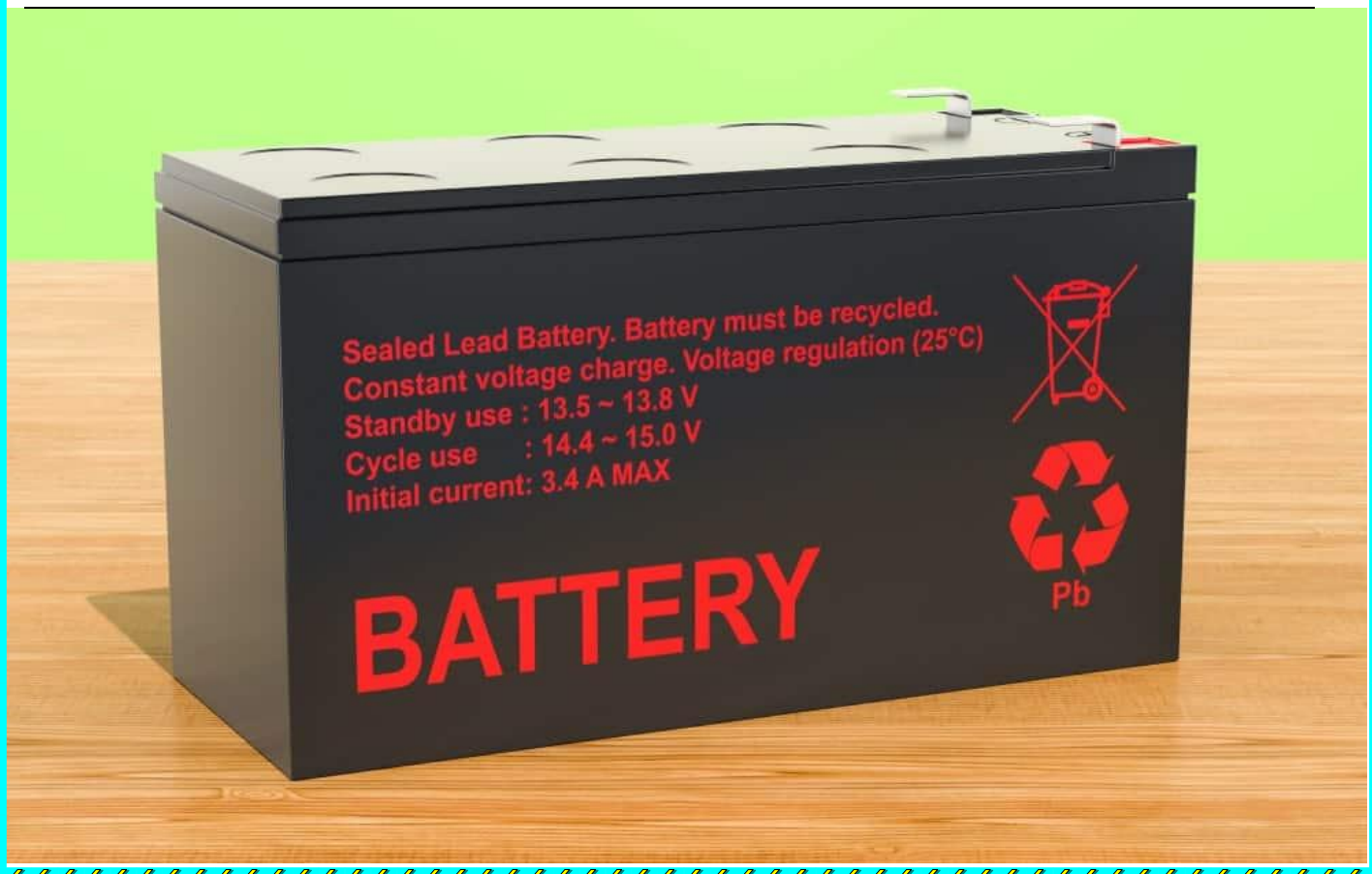
VRLA:

VRLA batteries are a medium to large, maintenance-free batteries that are sometimes called sealed lead-acid battery as well. Inside this battery, there are VRLA cells that consist of flat plates like a flooded lead-acid battery or a spiral roll.

VRLA batteries come with a pressure relief that gets activated when the pressure of hydrogen gas begins to build up. This valve activation results in the escaping of some of the gas and electrolyte. This, in turn, decreases the overall capacity of the battery.

One of the common methods to charge a VRLA battery is through constant-voltage charging. However, other methods are also used to charge VRLA methods quickly. Having VRLA in your car requires regular maintenance. Otherwise, incidents like short circuit and small fires can take place.

Batteries are undoubtedly the most reliable and compact ways to produce electrical energy in various devices, equipment, machinery, and vehicles. Without having different kinds of batteries, the world would have been a rough and tough place to live in.



The following table shows different types of batteries along with their characteristics and applications.

Battery Type	Characteristics	Applications
Zinc – Carbon	Common, low cost, variety of sizes	Radios, toys, instruments
Magnesium (Mg/MnO2)	High capacity, long shelf life	Military and aircraft Radios
Mercury (Zn/HgO)	Very high capacity, long shelf life	Medical (hearing aids, pacemakers), photography
Alkaline (Zn/Alkaline/MnO2)	Very popular, moderate cost, high performance	Most popular primary batteries
Silver/Zinc (Zn/Ag2O)	Highest capacity, costly, flat discharge	Hearing aids, photography, pagers
Lithium/Soluble Cathode	High energy density, good performance, wide temp range	Wide range of applications with capacity between 1 – 10,000 Ah
Lithium/Solid Cathode	High energy density, low temp performance, long shelf life	Replacement for button and cylindrical cells
Lithium/Solid Electrolyte	Low power, extremely long shelf life	Memory circuits, medical electronics

How to Choose a Battery?

Selecting a battery for your application can be dialled down to just two characteristics: Performance and Cost. But if we dig a little bit deeper, then the following are determining factors in choosing the right battery for your application.

- Primary or Secondary
- Energy or Power
- Shelf Life
- Energy Efficiency and Recharge Rate
- Battery Life
- Battery Temperature

Use the power of the sun to charge all of your fun!

Presented by:

Shaik Imran