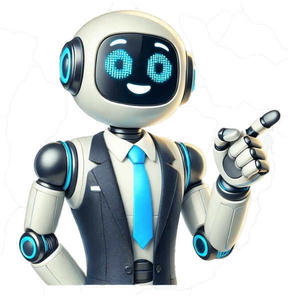

A cell is a powerhouse of electrical supply. It converts the stored energy into potential electrical energy. The generation of electrical current happens with the help of certain chemical reactions. A cell has several categories: primary cell, secondary cell, reserve cell, and fuel cell.A secondary cell is a type of cell that can be electrically recharged by passing current in the opposite direction of the circuit. One of the best examples of secondary cells is an alkaline battery. Energy in an alkaline battery is obtained from the interaction of zinc metal and manganese dioxide. These batteries live longer and have a greater energy density. It is called alkaline because of the electrolyte of potassium hydroxide that is used in it in place of acidic ammonium chloride.Chemistry of Secondary CellsThe electrolyte along with the other negative, as well as positive components, make up a secondary cell. These components are built of various materials. Furthermore, for the cell to work, the positive component must reduce the potential and the negative component must undergo oxidation. Hence, the aggregation of the potential of these two components produces the cell voltage.The alkaline batteries consist of zinc as the negative electrode and manganese as the positive electrode. The electrolyte of potassium hydroxide remains alone during the reaction. Zinc and manganese dioxide are utilized during the release. It must be noted that zinc is an excellent means to store chemical energy.Uses of secondary cellsSome gadgets that use secondary cells include car starters, electronic mobile devices, trains, small aeroplanes, and various types of tools. Additionally, there is immense scope for the use of secondary cells like alkaline batteries in hybrid automobiles.Furthermore, this technology helps in saving time, money and is environment-friendly. Older secondary cells degenerate pretty quickly and hence require mandatory charging before first use. Power stations for batteries can use secondary cells and alkaline batteries for storing electric energy during low demand periods and for storing power generated from solar rays during the day for later use. This process can help drastically reduce capital costs.Smaller secondary cells can power portable electronic gadgets, tools, and other applications.Other examples of secondary cellsBelow are other examples of Secondary Cells:Aluminium-ion batteryThese secondary cells are powered by a reaction between cathode and anode with other substances like air or graphite.Carbon batteryThese secondary cells were the first ones to be used commercially. They are made up of a reaction between zinc and manganese dioxide, and their composition is very similar to alkaline batteries.Flow batteryThis battery consists of one or more dissolved electro-active elements flowing through the electrochemical cell. In such batteries, the chemical energy is provided by two chemically-operated components dissolved in liquids.Lead-acid batteryThis battery has a low energy density as compared to other secondary cells. Its negative electrode is made of spongy and porous lead, which facilitates the formation and dissolution of lead. The positive electrode consists of lead oxide.Glass batteryIt is a solid-state battery that consists of glass electrolytes and lithium. The glass is highly conductive formed of lithium hydroxide and lithium chloride, it is additionally doped with barium.Lithium-ion batteryLithium ions are commonly used in consumer electronics, hence, these are the most popular secondary cells in use currently. In these batteries, lithium ions move from the negative electrode to the positive electrode via the electrolyte during the release.Magnesium-ion batteryAs the name suggests, these secondary cells utilise magnesium as the agent in the solution. Magnesium is heavier than lithium and is also safer compared to the latter. Furthermore, the cost-effectiveness of this type of secondary cell ensures a great future for it.ConclusionCells are an integral part of the technological world. They may be the smaller unit of a bigger operation but are of great importance when it comes to the day-to-day functioning of our lives. Rechargeable batteries or secondary cells are hence vital to the operation of our regular work and entertainment-related activities.While there is an increasing need for cost-effective and environmentally friendly inventions, secondary cells such as alkaline batteries or magnesium-ion batteries come as saviours of science and society. Therefore, secondary cells will have a growing importance in the days to come, and one must accept the transformations that they can lead to, and acknowledge the path they may pave for further inventions in physics. The article provides an overview of secondary cell, explaining its definition, types, and functionality, including Lead Acid, Nickel-Cadmium (NiCd), and Nickel Metal Hydride (NiMH) batteries. It discusses their construction, recharging processes, advantages, and safety aspects, as well as their applications in fields like automotive, electronics, and hybrid vehicles. Secondary CellA secondary cell can be recharged or restored. The chemical reaction that occurs on discharge may be reversed by forcing a current through the battery in the opposite direction. This charging current must be supplied from another source, which can be a generator or a power supply.Figure 1 shows one type of battery charger used for recharging automobile and motorcycle batteries. An alternating current, which will be studied in a later chapter, must be rectified to a direct current for charging the battery.Figure 1. This type of charger is called a trickle charger. It slowly brings a battery back to full charge.Lead Acid CellA common type of lead acid cell is the car storage battery. A storage battery does not store electricity. Rather, it stores chemical energy, which in turn produces electrical energy.The active ingredients in a fully charged battery are lead peroxide (PbO2), which acts as the positive plate, and pure spongy lead (Pb) for the negative plate.The liquid electrolyte is sulfuric acid (H2SO4) and water (H2O). The positive plates are a reddish-brown color. Negative plates are gray.The chemical reaction is rather involved. However, study the information given in Figure 2. Notice that during discharge, both the spongy lead and the lead peroxide (also called lead dioxide) plates are being changed to lead sulfate, and the electrolyte is being changed to water.When the cell is recharged, the reverse action occurs. The lead sulfate changes back to spongy lead and lead peroxide; the electrolyte to sulfuric acid.Figure 2. How a lead-acid cell works. (ESB Brands, Inc.)The electrolyte of a fully charged battery is a solution of sulfuric acid and water. The weight of a pure sulfuric acid is 1.835 times heavier than water. This is called its specific gravity.A Lesson in Safety:During the charging process of a storage battery, highly explosive hydrogen gas may be present. Do not smoke or light matches near charging batteries. Charge only in a well-ventilated room. Batteries should be first connected to the charger before the power is applied. Otherwise, the sparks made during connection might ignite the hydrogen gas and cause an explosion.Specific gravity is the weight of a liquid as it compares to water. The specific gravity of water is 1.000. The acid and water mixture in a fully charged battery has a specific gravity of approximately 1.300 or less.As the electrolyte changes to water when the cell discharges, the specific gravity becomes approximately 1.100 to 1.150. Therefore, the specific gravity of the electrolyte can be used to determine the state of charge of a cell.The instrument used to measure the specific gravity is a hydrometer. The principle of the hydrometer is based on Archimedes principle in physics.This principle states that a floating body will displace an amount of liquid equal to its own weight.If the cell is in a fully charged state, the electrolyte liquid is heavier, so the float in the hydrometer will not sink as far. The distance that the float does sink is calibrated in specific gravity on the scale. This can be read as the state of charge of the cell.CautionExpensive storage batteries may be destroyed by excessive vibration and rough handling. Chemicals may break off from the plates and cause internal short circuits and dead cells. Handle a battery gently and be sure it is securely clamped and bolted in your car.In the 12-volt automotive battery, six lead-acid cells are placed in a molded hard rubber case. Each cell has its own compartment.At the bottom of each compartment space, or sediment chamber is provided. This is where particles of chemicals broken from the plates due to chemical action or vibration can collect. Otherwise, these particles would short out the plates and make a dead cell. The individual cells are connected in series by lead alloy connectors.CautionAutomotive batteries contain large amounts of lead. Consequently, they should never be disposed of in landfills. Stores that sell automotive batteries are required by law to accept old batteries for recycling.Nickel-Cadmium cellThe nickel-cadmium cell is a rechargeable dry cell. Basically, these are nickel-cadmium alkaline batteries with paste rather than liquid for the electrolyte.The ability to be recharged is just one of their advantages. Other advantages include long life, high efficiency, compactness, and lightweight.The nickel-cadmium cell produces a high discharge current due to its low internal resistance. Other uses include the powering of small radios, burglar alarm systems, camera flashes, and aircraft instruments.One type of nickel-cadmium cell uses positive and negative plates, a separator, alkaline electrolyte, a metal case, and a sealing plate with a self-resealing safety vent. It is shown in Figure 3.The positive plate of this battery is a porous, powdered nickel base plate. It is filled with nickel hydroxide.The negative plate is a punched plate of thin steel, coated with cadmium active material. The separator is made of a polyamide fiber. For high-temperature uses, it is made of a nonwoven polypropylene fiber.The positive plate, separator, and negative plate are pressed together, wound into a coil, and inserted in the metal case.Figure 3. Construction of a nickel-cadmium cell. (Panasonic Battery Sales Division)The electrolyte is an alkaline aqueous solution. It is totally absorbed into the plate and separator.The metal case is constructed of nickel-plated steel. It is welded on the inside to the negative plate. It becomes the negative pole.The sealing plate uses a special liquid sealing agent to form a perfect seal. The positive plate is welded on the inside to the sealing plate. It becomes the positive pole.The self-resealing safety vent permits the discharge of gas in the event of an abnormal increase of internal pressure. This prevents against rupture or other damage.The vent is made of a special alkaline and oxidation resistant rubber. This ensures that operating pressure and safety features will be retained over a long period of time.The electromechanical processes of a nickel-cadmium alkaline cell are outlined below.\[\begin{align} & \begin{matrix} 2NiOOH & + & \begin{matrix} Cd & + & \begin{matrix} 2{{H}_{2}}O & \leftrightarrow & \begin{matrix} 2Ni{{\left(OH \right)}_{2}} & \begin{matrix} + & Cd{{\left(OH \right)}_{2}} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\& \begin{matrix} Positive & {} & \begin{matrix} Negative & Electrolyte & \begin{matrix} Positive & {} & \begin{matrix} Negative & \begin{matrix} {} & {} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{align}\]In this process, charging and discharging are reversed in a very efficient manner. The electrical energy used during discharge is regained during recharge. During the final charging stage, an oxygen gas is created with the reaction occurring at the positive.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} 4O{{H}^{-}} & \to & {{O}_{2}}\uparrow \\\end{matrix} & + & 2{{H}_{2}}O & + \\\end{matrix} & 4{{e}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Hydroxide & Oxygen & Water & Electrons \\\end{matrix} \\\end{align}\]This oxygen passes through the separator to the negative. After this, an absorption reaction takes place at the negative and absorption occurs.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} {{O}_{2}} & + & 2{{H}_{2}}O \\\end{matrix} & + & 4{{e}^{-}} & \to \\\end{matrix} & 4O{{H}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Oxygen & Water & Electrons & Hydroxide-Ions \\\end{matrix} \\\end{align}\]Nickel Metal Hydride CellNickel metal hydride (NiMH) is a rechargeable battery very similar to the NiCad battery.The NiMH battery uses nickel for the positive cathode and a hydrogen-absorbing alloy for the negative anode rather than cadmium, which is found in the NiCad battery.The fact that NiMH batteries do not use cadmium makes them environmentally friendly.Hydrogen-absorbing alloys are made from combinations of nickel and iron (Fe), magnesium (Mg), and lanthanum (La). The alloys can absorb large volumes of hydrogen equal to approximately 1000 times their weight without an increase in volume. This means the batteries can be sealed without the danger of explosion caused by the expansion of materials.A NiMH battery can have two to three times the storage capacity of a NiCad battery of equal size. This has made it an excellent battery for hybrid vehicles and portable computer applications.The discharge voltage level is 1.2 volts, which is the same as for NiCad batteries. The NiMH battery can be recharged over 500 times. The combined characteristics of the NiMH makes it an ideal replacement for existing NiCad battery applications.NiMH batteries should never be completely discharged. If they are, one or more of the cells can reverse polarity, which will result in permanent damage to the battery.Electronic devices that use NiMH batteries typically have a special circuit designed to detect low voltage levels and then disconnect the battery circuit before damage can occur.Secondary Cell Key TakeawaysThe secondary cell plays a vital role in various applications due to its ability to be recharged and reused. Examples of secondary cells, such as the lead-acid, nickel-cadmium (NiCd), and nickel-metal hydride (NiMH) batteries, provide energy solutions across multiple industries. The lead-acid secondary cell is widely used in automotive batteries, while the nickel-cadmium secondary cell is common in smaller electronic devices. The nickel-metal hydride secondary cell, with its higher energy density and environmental benefits, is increasingly found in hybrid vehicles and advanced electronics. The ability of secondary cells to be recharged makes them an essential part of modern technology, offering both economic and environmental advantages by reducing waste. Their significance will only grow as technology continues to advance, ensuring they remain a cornerstone in energy storage solutions. Secondary Cells are characterized by reversible chemical reactions, These cells can be recharged by passing an electric current from external source between their poles in a direction opposite to the discharge process, Secondary Cells such as Lead-Acid battery and Lithium-ion battery, Lead storage cell is used as a galvanic cell and electrolytic cell. Lead-Acid batteryLead-acid battery is from secondary galvanic cells, It is known as a Car battery (liquid battery) because this kind of batteries is developed and becomes the most suitable kind of batteries used in cars, It consists of six cells are connected in series, Each cell produces Ecell = 2 volt and the total cell potential of the battery is emf = 2 6 = 12 volts, This battery works as a galvanic cell during operation (discharging) while in case of recharging it is considered as an electrolytic cell. Plates of lead-acid battery are separated from each other by insulating sheets and all of which are put in dilute sulphuric acid solution (H2SO4) as a conducting electrolyte and all of which are put in a container made of solid rubber or plastic (polystyrene) which is not affected by acids, The anode is a network of lead filled with spongy lead (Pb).The anode reaction: Pb + SO42 PbSO4 + 2 eThe cathode is a network of lead filled with a paste of lead dioxide (PbO2).The cathode reaction: PbO2 + 4 H+ + SO42+ 2 e PbSO4 + 2 H2OThe total cell reaction: Pb + PbO2 + 4 H+ + 2 SO42 2 PbSO4 + 2 H2OThe cell potential = 2 volts, Electromotive force = 2 6 = 12 volts.Discharge reactionAt the anode: Pb + SO42 PbSO4 + 2e, The anode will be covered with a layer of PbSO4, E = 0.36 V, The standard oxidation potential of this reaction = 0.36 Volt.At the cathode: PbO2 + 4H+ + SO42 + 2e PbSO4 + 2 H2O, The cathode will be covered with a layer of PbSO4, E = 1.69 V, The standard reduction potential of this potential = + 1.69 Volt, The cell works here as a galvanic cell and at discharging the total battery reaction is:Pb + PbO2 +4 H+ + 2 SO42 2 PbSO4 + 2 H2O, Ecell = 2.05 VCalculate the electromotive force for this cellThe state of the battery can be identified by measuring the density of the acid by using a hydrometer (measuring liquid density), When the battery is completely charged, the density of acid = 1.28: 1.30 gm/cm, When the density of the acid is decreased to lower than 1.2 gm/cm, this means that the battery needs to be recharged and increasing its acid concentration. Charging reactionUsing the battery for a long period leads to a decrease the concentration of sulphuric acid as a result of increasing the quantity of water produced from the reaction and also leads to the conversion of cathode material (PbO2) and anode (Pb) to lead (II) sulphate which lead to decrease of the quality of electric current produced from it.Car battery is reversible cell, The battery needs to be recharged and this is done by connecting the battery poles to an outside source of direct electric current whose potential is slightly higher than the potential produced from the battery, this will lead to reversing of the spontaneous reaction which occurred during the discharge of the battery and leads to conversion of lead sulphate (PbSO4) to lead (Pb) at the anode and lead dioxide (PbO2) at the cathode and the concentration of the acid renewed as it was.2 PbSO4 + 2 H2O Pb + PbO2 + 2 SO42+4 H+The lead-acid battery works during charging as an electrolytic cell, The secondary cells are considered as strong batteries, The car dynamo in a continuous way is used in recharging the battery first by first, where a nonspontaneous chemical reaction occurs by passing electric current, this means the storage of electric energy which comes from the external source in the form of chemical energy.The Dynamo of the car is used in recharging the battery once when it is discharged, The lead-acid battery is considered as a reversible cell because when it is connected to outside source of direct electric current whose potential is slightly higher than the potential produced from the battery, oxidation reactions are converted into reduction reactions and vice versa. The total cell potential of the car battery is 12 Volts, although the potential of lead-acid is 2 Volts because the car battery consists of 6 cells of 2 volts per each, which are connected in series, The container of the lead-acid battery made from solid rubber or plastic because it is not affected by acids like sulphuric acid.The lead-acid battery needs recharging because the long period for using the battery leads to the dilution of sulphuric acid concentration, The continuous use of the battery for long time decreases the electric current produced because H2O amount increases which decrease the concentration ofH2SO4, so, the acid becomes weak, Pb, PbO2 are consumed, PbSO4 is formed and the density of the acid decreased (less than 1.2 gm/cm).Mercury cell is alkaline, while the lead-acid battery is acidic because the electrolyte used in mercury cell is potassium hydroxide, while the electrolyte used in the lead-acid battery is dilute sulphuric acid, The recharging reaction is non-spontaneous reaction and needs an outside electric source, so, the cell here is an electrolytic cell where the electric energy is used to produce a chemical reaction, it is known as secondary cell, In the car, the dynamo in a continuous way is used in recharging the battery first by first. The density of the sulphuric acid in the battery can identify the car battery condition because the density of acid in the completely charged battery ranges between 1.28 to 1.30 g/cm, If the acid density decreased to lower than 1.2 g/cm, this means that the battery needs to be recharged and increase its acid concentration.Lithium-ion batteryLithium battery is a secondary cell, It is a dry and rechargeable battery used in mobiles, laptop, the modern cars instead of the lead acid battery, it is lighter and stores a large amount of energy while it is small in size, Lithium is used in structure of lithium-ion battery because it has the lowest reduction potential (3.04 volt) and it is the lightest metal (structure). It is the lightest metal (lighter than Pb), Its ions have a small size, It has high storage capacity, It can be recharged several times and can be used for many years, The metallic cover of the battery contains three thin layers rolled in a spiral shape, these layers are cathode and anode which are separated by an isolator and dipped in the anhydrous electrolytic solution.The anode (negative pole): Carbon layer contains Li metal called lithium graphite (LiC6).The anode (oxidation) reaction: LiC6 C6 + Li+ + e The cathode (positive pole): Cobalt oxide containing Li+ called Lithium cobalt oxide (LiCOO2).The cathode (reduction) reaction: COO2 + Li+ + e LiCOO2Electrolyte is Lithium hexafluoride phosphate LiPF6, it is a nonpolar solvent, so, it doesnt reduce the Li+, It is a nontoxic substance and it has high thermal stability, The isolator is made of a very thin porous layer of plastic separate between anode and cathode but it allows the ions to pass through it,Electromotive force = 3 V. The total cell reaction: LiC6 + COO2 C6 + LiCOO2, Ecell = 3 VLithium is used in the manufacture of batteries because it has the lowest reduction potential of all the metals and the highest metal, The lithium-ion battery is prefered than the lead-acid battery because no gases evolve from it, the life time of this battery is long, it can be recharged and used for several years.The secondary cells are considered as a battery which stores the electrical energy because it can be discharged by converting the chemical energy into electrical energy when it is needed and it can be recharged by passing an electric current from an external source.Galvanic cells, Primary cells (Mercury cell & Fuel cell) and the production of electric energyCorrosion causes, Protection of metal against corrosion, Mechanism of iron & steel rusting The major difference between a primary cell and the secondary cell is that primary cells are the ones that cannot be charged but secondary cells are the ones that are rechargeable. Before heading towards the discussion of differences between both cells, let us learn about them in brief. Difference Between Primary Cell and Secondary Cell Non-rechargeable batteries are also known as primary cells or primary batteries. This is primarily due to the fact that once these batteries are depleted, they cannot be recharged. Although they are not reusable, primary cells are very useful for storing power for long-term use due to their low self-discharge rate. As a result, they are used in service pacemakers for heart patients, smart meters, and military campaigns where charging is impractical or impossible. Because of the irreversible chemical reactions that occur inside the battery, primary cells are non-rechargeable. The chemical reactions use all of the chemicals in the cell, and once all of the chemical species are used, power generation stops. A primary battery or primary cell is made up of an anode (positively charged end) and a cathode (negatively charged end) (negatively charged end). The cathode is typically graphite, and the anode is zinc. The anode undergoes oxidation reactions in which electrons are donated to the circuit, while the cathode undergoes reduction reactions in which electrons are accepted from the outside. There is also an electrolyte, which aids in the passage of electric current. The electrolyte is made up of electrically charged ions that can transfer their charge between the cathode and the anode. A common example of primary cell isLeclanche cell. It is composed of a Zinc anode and porous graphite cathode. The electrolyte present inside the battery is a moist mixture of NH4Cl (ammonium chloride), Zinc chloride (ZnCl2) and Manganese dioxide (MnO2). The chemical reactions that occur inside the cell can be given as below. Anode: Zn (s) Zn2+(aq) + 2e Cathode: 2NH4+(aq)+ 2e 2NH3 (g) + H2 (g) Hence two gases NH3and H2are produced in the cathode. But these gases again will participate in reactions as shown below. 2NH3 (g)+ Zn2+(aq) [Zn(NH3)2]2+(aq) 2MnO2 (s)+ H2 (g)Mn2O3 (s)+H2O (l) Secondary cells are also known as rechargeable batteries or secondary batteries. Because they can be recharged, these batteries can be used multiple times. Reversible chemical reactions occur in these batteries. Thus by applying an electrical charge, those reactions can be reversed. Secondary batteries, unlike primary batteries, must be charged before use. Chargers are used to recharge batteries. Different secondary batteries however serve with different purposes. As a result, the user should understand which type of battery to use for a specific need. These batteries, like primary batteries, also have a cathode and anode. Reduction reactions take place in the cathode, whereas oxidation reactions take place in the anode. The lead storage/acid battery is hence an excellent example of secondary cells. The reactions that occur within that cell are depicted below. Cathode: PbO2 (s) + HSO4(aq) + 3H+(aq)+ 2e PbSO4 (s)+ H2O (l) Anode: Pb (s) + HSO4(aq) PbSO4 (s)+ H+(aq)+ 2e Primary CellSecondary cellDefinitionPrimary cells are batteries that cannot be easily recharged after use. Secondary cells are batteries that can be recharged and reused.Chemical ReactionsIn primary cells, irreversible reactions occur.In primary cells, reversible reactions occur.DesignPrimary cells are frequently referred to as dry cells due to the technology used to create them. Because there are no fluids in the battery, but the cells are filled with paste that allows the ions to move but prevents them from spilling.Secondary cells make use of the other two types of cells: wet cells (flooded cells) and molten salt cells (liquid cells with a slightly different composition).UsagePrimary cells can be used only once.Secondary cells can be used more than once.SpecificationsPrimary cells have a high internal resistance, an irreversible chemical reaction, a higher capacity, are typically smaller and lighter, and are generally less expensive.Secondary cells have a lower internal resistance, require charging, have reversible chemical reactions, and are more complex and costly.DischargeIn comparison, it has a slow discharge.Comparatively higher discharge.ApplicationPrimary cells are used in devices that require a small but constant current, such as clocks, toys, and safety equipment.Secondary cells are used in portable devices laptops, mobile phones, mp3 players, tablets, etc.CostPrimary cellsare cheap and easy to use and these cellare cost effective compared tosecondary cells, initially.Secondary cellsare expensive and more complex in usage. however, usingthese cellswould be a long term investment since primary cells are to be replaced by another set after some time. ~:text=The%20major%20difference%20between%20a,the%20ones%20that%20are%20rechargeable. chemistries- faq/ -vs-secondary- cells/ electrochemistry-battery_ chemistry/ About AuthorElectrochemical cellElectrolytic cellIt is a device which converts chemical energy into electrical energy.It is a device which converts electrical energy into chemical energy.The redox reaction is spontaneous and is responsible for the production of electrical energy.The redox reaction is non-spontaneous and electrical energy is supplied to make the reaction to occur.The two half cells are set up in different containers and are connected through salt bridge or porous partition.Both the electrodes are placed in the solution or molten electrolyte in the same container.In electrochemical cell, anode is negative and cathode is positive electrode.In electrolytic cell, anode is positive and cathode is negative electrode.The electrons move from anode to cathode in external circuit.The electrons are supplied by the external battery and enter through cathode and come out through anode. A battery is an arrangement of electrochemical cells used as an energy source. The basis of an electrochemical cell is an oxidation-reduction reaction. A useful battery should also fulfil the following requirements1) It should be light and compact so that it can be easily transported.2) It should have reasonably long life both when it is being used and when it is not used.3) The voltage of the battery should not vary appreciably during its use.Types of commercial cellsThere are mainly two types of commercial cells:1) Primary batteries or cells2) Secondary batteries or cellsPrimary batteries or cellsIn these cells, the electrode reactions cannot be reversed by an external electric energy source. In these cells, reactions occur only once and after use they become dead. Therefore, they are not chargeable. Some common examples are dry cell, mercury cell.Secondary batteries or cellsIn the secondary cells, the reactions can be reversed by an external electric energy source. Therefore, these cells can be recharged by passing electric current and used again and again. These are also called storage cells. Examples of secondary cells are lead storage battery and nickel-cadmium storage cell.1) Primary Cells1) Dry cells These are used in torches, toys, flash lights, calculators, tape recorders and many other devices.Construction of Dry Cella) It consists of a zinc cylinder. This is filled with a moist paste of NH4Cl and little of ZnCl2.b) The zinc cylinder acts as a anode. The cathode is a graphite (carbon) rod.c) The carbon rod is surrounded by a black paste of manganese dioxide (MnO2) and carbon powder. d) During use, the zinc case gets consumed and in the end, it will develop holes which are responsible for leakages. The leak proof cells or dry cells have an iron or steel sheet covering the zinc.Working of Dry CellZinc loses electrons and Zn2+ ions dissolve in the electrolyte. The electrons pass around the external circuit and are taken up at cathode. This causes discharge of NH4+ ions from the electrolyte. The reactions taking place at the electrodes are:AnodeZn > Zn2+ + 2eCathode NH4+(aq) + MnO2(s) +2e -> MnO(OH) + NH3-Zn + 2NH4+ (aq) + 2MnO2(s) ->Zn2+ + 2MnO(OH) +2NH3 In the cathode reaction, manganese is reduced from +4 Oxidation state to +3oxidation state. Ammonia is not liberated as a gas but it Combines with some of the Zn2+ ions produced from the anode to form Complexion having the formula [Zn(NH3)2]2+It gives voltage of approximately 1.2 to 1.5 V. This dry cell does not have an indefinite life because NH4Cl being acidic corrodes the zinc Container even when not in use.2) Mercury cell A new type of cell which has found use in small electrical circuits such as hearing aids, Watches and cameras is the mercury cell. Itconsists of a zinc anode and a mercury (II) oxide cathode. The electrolyte is a paste of KOH and ZnO. The reactions occurring in the cell are as follows :Anode:Zn(Hg) + 2OH ZnO(s) + H2O+ 2eCathode:HgO(s) + H2O+ 2e Hg(l) + 2OH-Zn + HgO(s) -> ZnO(s) + Hg(l)(Amalgam)It has the advantage that its potential remains almost constant throughout its life. The voltage of mercury cell is approximately 1.35 V.2) Secondary CellsThere are some cells which can be recharged. These are called accumulators or storage cells. These can be recharged and used again and again as a source of electric current. Lead Storage CellEach battery consists of a number of voltaic cells connected in series. Three to six such cells are generally combined to get 6 to 12 volt battery.a) The anode is a grid of lead packed with finely divided spongy lead and the cathode is a grid of lead packed with PbO2.b) The electrolyte is aqueous solution of sulphuric acid.c) At the anode, lead is oxidised to Pb2+ ions and insoluble PbSO4, is formed. At the cathode PbO2, is reduced to Pb2+ ions and PbSO4 is formed.The following reactions take place in the lead storage cell: At anodeThe lead loses two electrons and is oxidised to Pb2+ ions.Pb(s) -> Pb2+(aq) +2 ePb2+(aq) + SO42-(aq) > PbSO4(s)The overall anode reaction may be written as :Pb(s)+ SO42-(aq) > PbSO4(s) + 2eAt cathode The PbO2 is reduced as:PbO2 (s) + 4 H+ +2 e > Pb2+(aq) + 2 H2OPbO2 (s) + SO42-(aq) ->PbSO4(s)The overall cathode reaction is :PbO2 (s) + 4 H+ +2 e + SO42-(aq) -> PbSO4(s) + 2 H2OPb(s)+ SO42-(aq) > PbSO4(s) + 2ePbO2 (s) + 4 H+ +2 e + SO42-(aq) -> PbSO4(s) + 2 H2OPb(s) + PbO2 (s) + 2 H2SO4 (aq) > 2 PbSO4(s) + 2 H2ODuring the working of the cell PbSO4 is formed at each electrode and sulphuric acid is used up. As a result, the concentration of H2SO4 decreases and the density of the solution also decreases. Recharging the BatteryThe cell can be charged by passing electric current of a suitable voltage in the opposite direction. The electrode reaction gets reversed. As a result, the flow of electrons gets reversed and lead is deposited on anode and PbO2 on the cathode. The density of sulphuric acid also increases. The reaction may be Written as2PbSO4 (s)+2H2O >Pb(s) + PbO2 (s) +2H2SO4When it is used to start the engine of the automobile, it acts as a voltaic cell and produces electric energy. During recharging, it acts as an electrolytic cell.Nickel Cadmium Storage CellThis is also a rechargeable cell. It has longer life than the lead storage cell but more expensive than lead storage battery. However, it has some advantages because it is smaller and lighter. It can be used in portable and cordless appliances. 1) It consists of a cadmium anode and a metal grid containing NiO2 acting as a cathode.2) The electrolyte in this cell is KOH.The reactions taking place during discharge and charge are:Anode:Cd(s)+2OH CdO(s) +H2O(l)+ 2eCathode:2Ni(OH3) (s) + 2e 2Ni(OH)2(s) +2OH (aq)Cd(s)+ 2Ni(OH3) (s) CdO(s) + 2Ni(OH)2(s) + H2O(l)-The reaction products generally remain sticking to the electrodes and can be reconverted by recharging the cell. The charging process is similar to lead storage battery.It produces a potential of about 1.4 V. Fuel CellsThese are voltaic cells in which the reactants are continuously supplied to the electrodes. These are designed to convert the energy from the combustion of fuels such as H, CO, CH4, etc. directly into electrical energy. 1) In this cell, hydrogen and oxygen are bubbled through a porous carbon electrode into concentrated aqueous sodium hydroxide or potassium hydroxide.2) Hydrogen (the fuel) is fed into the anode compartment where it is oxidised. 3) The oxygen is fed into cathode compartment where it is reduced. The reactions are:Anode:2[H2(g)+ 2OH(aq) >2H2O(l)+2e]CathodeO2(g)+ 2H2O(l) + 4e >4OH (aq)2H2(g) +02(g)-> 2H2O (l)Each electrode is made of porous compressed carbon containing a small amount of catalyst (Pt, Ag or CoO).These fuel cells are more efficient than conventionally used methods of generating electricity on a large scale by burning hydrogen, carbonfuels because these fuel cells convert the energy of the fuel directly into electricity.Advantages of fuel cells over ordinary batteries:1) High efficiencyThe fuel cells convert the energy of a fuel directly into electricity and therefore, they are more efficient than the conventional methods of generating electricity on a large scale by burninghydrogen, carbon fuels.The conventionalmethods of production of electrical energy involve combustion of a fuelto liberate heat which is then used to produce electricity. The efficiency of these methods is only about 40%.2) Continuous source of energyThere is no electrode material to be replaced as in ordinary battery. The fuel can be fed continuously to produce power. (3) Pollution free workingThere are no objectionable by-products and, therefore, they do not cause pollution problems. The article provides an overview of secondary cell, explaining its definition, types, and functionality, including Lead Acid, Nickel-Cadmium (NiCd), and Nickel Metal Hydride (NiMH) batteries. It discusses their construction, recharging processes, advantages, and safety aspects, as well as their applications in fields like automotive, electronics, and hybrid vehicles. Secondary CellA secondary cell can be recharged or restored. The chemical reaction that occurs on discharge may be reversed by forcing a current through the battery in the opposite direction. This charging current must be supplied from another source, which can be a generator or a power supply.Figure 1 shows one type of battery charger used for recharging automobile and motorcycle batteries. An alternating current, which will be studied in a later chapter, must be rectified to a direct current for charging the battery.Figure 1. This type of charger is called a trickle charger. It slowly brings a battery back to full charge.Lead Acid CellA common type of lead acid cell is the car storage battery. A storage battery does not store electricity. Rather, it stores chemical energy, which in turn produces electrical energy.The active ingredients in a fully charged battery are lead peroxide (PbO2), which acts as the positive plate, and pure spongy lead (Pb) for the negative plate.The liquid electrolyte is sulfuric acid (H2SO4) and water (H2O). The positive plates are a reddish-brown color. Negative plates are gray.The chemical reaction is rather involved. However, study the information given in Figure 2. Notice that during discharge, both the spongy lead and the lead peroxide (also called lead dioxide) plates are being changed to lead sulfate, and the electrolyte is being changed to water.When the cell is recharged, the reverse action occurs. The lead sulfate changes back to spongy lead and lead peroxide; the electrolyte to sulfuric acid.Figure 2. How a lead-acid cell works. (ESB Brands, Inc.)The electrolyte of a fully charged battery is a solution of sulfuric acid and water. The weight of a pure sulfuric acid is 1.835 times heavier than water. This is called its specific gravity.A Lesson in Safety:During the charging process of a storage battery, highly explosive hydrogen gas may be present. Do not smoke or light matches near charging batteries. Charge only in a well-ventilated room. Batteries should be first connected to the charger before the power is applied. Otherwise, the sparks made during connection might ignite the hydrogen gas and cause an explosion.Specific gravity is the weight of a liquid as it compares to water. The specific gravity of water is 1.000. The acid and water mixture in a fully charged battery has a specific gravity of approximately 1.300 or less.As the electrolyte changes to water when the cell discharges, the specific gravity becomes approximately 1.100 to 1.150. Therefore, the specific gravity of the electrolyte can be used to determine the state of charge of a cell.The instrument used to measure the specific gravity is a hydrometer. The principle of the hydrometer is based on Archimedes principle in physics.This principle states that a floating body will displace an amount of liquid equal to its own weight.If the cell is in a fully charged state, the electrolyte liquid is heavier, so the float in the hydrometer will not sink as far. The distance that the float does sink is calibrated in specific gravity on the scale. This can be read as the state of charge of the cell.CautionExpensive storage batteries may be destroyed by excessive vibration and rough handling. Chemicals may break off from the plates and cause internal short circuits and dead cells. Handle a battery gently and be sure it is securely clamped and bolted in your car.In the 12-volt automotive battery, six lead-acid cells are placed in a molded hard rubber case. Each cell has its own compartment.At the bottom of each compartment space, or sediment chamber is provided. This is where particles of chemicals broken from the plates due to chemical action or vibration can collect. Otherwise, these particles would short out the plates and make a dead cell. The individual cells are connected in series by lead alloy connectors.CautionAutomotive batteries contain large amounts of lead. Consequently, they should never be disposed of in landfills. Stores that sell automotive batteries are required by law to accept old batteries for recycling.Nickel-Cadmium cellThe nickel-cadmium cell is a rechargeable dry cell. Basically, these are nickel-cadmium alkaline batteries with paste rather than liquid for the electrolyte.The ability to be recharged is just one of their advantages. Other advantages include long life, high efficiency, compactness, and lightweight.The nickel-cadmium cell produces a high discharge current due to its low internal resistance. Other uses include the powering of small radios, burglar alarm systems, camera flashes, and aircraft instruments.One type of nickel-cadmium cell uses positive and negative plates, a separator, alkaline electrolyte, a metal case, and a sealing plate with a self-resealing safety vent. It is shown in Figure 3.The positive plate of this battery is a porous, powdered nickel base plate. It is filled with nickel hydroxide.The negative plate is a punched plate of thin steel, coated with cadmium active material. The separator is made of a polyamide fiber. For high-temperature uses, it is made of a nonwoven polypropylene fiber.The positive plate, separator, and negative plate are pressed together, wound into a coil, and inserted in the metal case.Figure 3. Construction of a nickel-cadmium cell. (Panasonic Battery Sales Division)The electrolyte is an alkaline aqueous solution. It is totally absorbed into the plate and separator.The metal case is constructed of nickel-plated steel. It is welded on the inside to the negative plate. It becomes the negative pole.The sealing plate uses a special liquid sealing agent to form a perfect seal. The positive plate is welded on the inside to the sealing plate. It becomes the positive pole.The self-resealing safety vent permits the discharge of gas in the event of an abnormal increase of internal pressure. This prevents against rupture or other damage.The vent is made of a special alkaline and oxidation resistant rubber. This ensures that operating pressure and safety features will be retained over a long period of time.The electromechanical processes of a nickel-cadmium alkaline cell are outlined below.\[\begin{align} & \begin{matrix} 2NiOOH & + & \begin{matrix} Cd & + & \begin{matrix} 2{{H}_{2}}O & \leftrightarrow & \begin{matrix} 2Ni{{\left(OH \right)}_{2}} & \begin{matrix} + & Cd{{\left(OH \right)}_{2}} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\& \begin{matrix} Positive & {} & \begin{matrix} Negative & Electrolyte & \begin{matrix} Positive & {} & \begin{matrix} Negative & \begin{matrix} {} & {} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{align}\]In this process, charging and discharging are reversed in a very efficient manner. The electrical energy used during discharge is regained during recharge. During the final charging stage, an oxygen gas is created with the reaction occurring at the positive.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} 4O{{H}^{-}} & \to & {{O}_{2}}\uparrow \\\end{matrix} & + & 2{{H}_{2}}O & + \\\end{matrix} & 4{{e}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Hydroxide & Oxygen & Water & Electrons \\\end{matrix} \\\end{align}\]This oxygen passes through the separator to the negative. After this, an absorption reaction takes place at the negative and absorption occurs.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} {{O}_{2}} & + & 2{{H}_{2}}O \\\end{matrix} & + & 4{{e}^{-}} & \to \\\end{matrix} & 4O{{H}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Oxygen & Water & Electrons & Hydroxide-Ions \\\end{matrix} \\\end{align}\]Nickel Metal Hydride CellNickel metal hydride (NiMH) is a rechargeable battery very similar to the NiCad battery.The NiMH battery uses nickel for the positive cathode and a hydrogen-absorbing alloy for the negative anode rather than cadmium, which is found in the NiCad battery.The fact that NiMH batteries do not use cadmium makes them environmentally friendly.Hydrogen-absorbing alloys are made from combinations of nickel and iron (Fe), magnesium (Mg), and lanthanum (La). The alloys can absorb large volumes of hydrogen equal to approximately 1000 times their weight without an increase in volume. This means the batteries can be sealed without the danger of explosion caused by the expansion of materials.A NiMH battery can have two to three times the storage capacity of a NiCad battery of equal size. This has made it an excellent battery for hybrid vehicles and portable computer applications.The discharge voltage level is 1.2 volts, which is the same as for NiCad batteries. The NiMH battery can be recharged over 500 times. The combined characteristics of the NiMH makes it an ideal replacement for existing NiCad battery applications.NiMH batteries should never be completely discharged. If they are, one or more of the cells can reverse polarity, which will result in permanent damage to the battery.Electronic devices that use NiMH batteries typically have a special circuit designed to detect low voltage levels and then disconnect the battery circuit before damage can occur.Secondary Cell Key TakeawaysThe secondary cell plays a vital role in various applications due to its ability to be recharged and reused. Examples of secondary cells, such as the lead-acid, nickel-cadmium (NiCd), and nickel-metal hydride (NiMH) batteries, provide energy solutions across multiple industries. The lead-acid secondary cell is widely used in automotive batteries, while the nickel-cadmium secondary cell is common in smaller electronic devices. The nickel-metal hydride secondary cell, with its higher energy density and environmental benefits, is increasingly found in hybrid vehicles and advanced electronics. The ability of secondary cells to be recharged makes them an essential part of modern technology, offering both economic and environmental advantages by reducing waste. Their significance will only grow as technology continues to advance, ensuring they remain a cornerstone in energy storage solutions. What is a secondary cell? Nameonesuch cell.Secondary cells are cells which provide current as a result of reversible chemical reactions. It converts electrical energy into chemical energy when current is passed in it (i.e. during charging), while it converts chemical energy into electrical energy when current is drawn from it (i.e., during discharging).Example: Lead (or acid) accumulator.shaalaa.comTypes of Circuits: Simple CircuitIs there an error in this question or solution?Secondary / rechargeable cells employ chemical reactions which can be reversed by applying a voltage greater than the cell voltage, causing electrons to push in the opposite directionThere are many types of rechargeable cells, but common ones include:Lead-acid batteries,Nickel-cadmium / NiCad cellsLithium cellsA lead-acid battery is made up of six cells connected in seriesEach cell uses lead as the negative electrode and lead(IV) oxide as the positive electrodeThe electrolyte is sulfuric acidA lead acid battery is made by placing negative lead and positive lead dioxide electrodes into the sulfuric acid electrolyteThe half-cell reactions arePb (s) + SO42- (aq) PbSO4(s) + 2e- E= -0.36 VPbO2(s) + 4H+ (aq) + SO42- (aq) + 2e- PbSO4 (s) + 2H2O (l) E= +1.70 VThe cell generates an EMF of about 2 V and the overall reaction isPbO2 (s) + 4H+ (aq) + 2SO42- (aq) + Pb (s) 2PbSO4 (s) + 2H2O (l) Ecell = +2.06 VIn cars, six cells provide about 12 VWhile driving, the generator reverses the discharge reaction, regenerating the electrodesThese batteries are designed to deliver a high current for a short period, ideal for starting enginesDisadvantages of lead-acid batteriesVery heavy and bulkyContain toxic materials: lead and lead dioxideSulfuric acid is highly corrosiveDisposal and recycling pose significant environmental challengesNiCad cellsNickel-cadmium cells are available in many standard sizes and voltages so they can replace almost any application of traditional zinc-carbon cellsAlthough they are more expensive cells, the fact they can be recharged hundreds of times means they are commercially viableThe negative electrode consists of cadmium and the positive electrode is made of a nickel(II) hydroxide-oxide systemThe half-cell reactions areCd (s) + 2OH-(aq) Cd(OH)2 (s) + 2e- E= -0.82 VNiO(OH) (s) + H2O (l) + e- Ni(OH)2 (s) + OH- (aq) E= +0.38 VThe overall reaction in the cell is2NiO(OH) (s) + 2H2O (l) + Cd (s) 2Ni(OH)2 (s) + Cd(OH)2 (s) E= +1.2 VDisadvantages of NiCad batteriesCadmium is toxic, making disposal hazardousCells must be properly recycled to avoid environmental contaminationNiCad batteries can suffer from the memory effect If the cell is recharged repeatedly without being fully discharged, it may gradually lose capacityThis reduces performance and shortens their usable lifespan unless carefully managedLithium-ion cellLithium-ion cells are common in phones, laptops, and other portable devicesLithium is chosen for its low density and high electrode potentialThe Nobel Prize in Chemistry (2019) was awarded to Goodenough, Whittingham, and Yoshino for developing this technologyStructure:The cell consists of:Positive electrode: lithium cobalt oxideNegative electrode: carbonElectrolyte: solid polymer membrane (non-leaking and safer than liquid types)The polymer electrolyte cannot leak since it is not a liquid or paste, which presents advantages over other types of cellsLithium-ion cellThe lithium-ion cell consists of a positive lithium cobalt oxide electrode and a negative carbon electrodeThe cell consists of a sandwich of different layers of lithium cobalt oxide and carbonLithium-ion discharge mechanismLithium ions move between electrodes through the polymer electrolyte during charge/dischargeThe half-cell reactions on discharge are:Li (s) Li+ (s) + e E = -3 VLi+ (s) + CoO2 (s) +e Li + (CoO2) (s) E = +1 VThe cell generates an EMF of between 3.5 V and 4.0 V and the overall reaction is Li (s) + CoO2 (s) Li + (CoO2) (s) Ecell ~ +3.5Advantages of lithium-ion cellsLightweight and high voltage outputNo toxic heavy metals like lead or cadmiumNo memory effect (unlike NiCad cells), so topping up charge doesn't reduce capacityDisadvantages of lithium-ion cellsDegrade over time cells lose capacity with repeated cyclesLithium supply is limited, raising concerns about long-term sustainabilityIf not recycled, lithium becomes a lost resourceFire risk lithium is reactive, and damaged cells can overheat or combustThis section compares key features of different cell types, with a focus on performance, environmental impact, and safety:Primary cellsCheap to produce, lightweight, and have a long shelf lifeCannot be recharged disposal after one use contributes to landfill wasteOnly suitable for low-power devices due to limited current outputFuel cellsProduce lower emissions if hydrogen is used as the fuelMore energy-efficient than combustion enginesHydrogen is flammable and must be stored under high pressure in heavy tanksExpensive to produce and can suffer from catalyst wear, leakage, or corrosionGenerally provide a steady but low electrical currentCan be recharged multiple times, regenerating their chemical reactantsProvide enough current for demanding applications like power tools and vehiclesLead-acid batteriesCan deliver large amounts of energy quickly ideal for starter motorsHeavy and bulkyContain toxic lead and corrosive sulfuric acid disposal is environmentally challengingNickel-cadmium (NiCad) cellsLonger life than lead-acid batteriesCadmium is highly toxicProduce relatively low voltageExpensive compared to alternativesLithium-ion cellsLightweight due to lithiums low densityDeliver a high voltage output (typically 3.54.0 V)Free from toxic metals like lead or cadmiumGradually lose capacity with repeated useExpensive and dependent on finite lithium resourcesRisk of overheating or fire, especially if damaged or improperly handledPage 2We have seen previously that redox reactions involve simultaneous oxidation and reduction as electrons flow from the reducing agent to the oxidising agentWhich way electrons flow depends on the reactivity of the species involvedRedox chemistry has very important applications in electrochemical cells, which come in two types:Voltaic cellsElectrolytic cellsA voltaic cell generates a potential difference known as an electromotive force or EMFThe EMF is also called the cell potential and is given the symbol EThe absolute value of a cell potential cannot be determined only the difference between one cell and anotherThis is analogous to arm-wrestling: you cannot determine the strength of an arm-wrestler unless you compare them to the other competitorsVoltaic (or Galvanic) cells generate electricity from spontaneous redox reactions, e.g.Zn (s) + CuSO4 (aq) Cu (s) + ZnSO4(aq)Instead of electrons being transferred directly from the zinc to the copper ions, a cell is built which separates the two redox processesEach part of the cell is called ahalf-cellIf a rod of metal is dipped into a solution of its own ions, an equilibrium is set upZn (s)Zn2+(aq)+ 2eWhen a metal is dipped into a solution containing its ions, an equilibrium is established between the metal and its ionsThis is ahalf-celland the strip of metal is anelectrodeThe position of the equilibrium determines thepotential differencebetween the metal strip and the solution of metalThe Zn atoms on the rod can deposit two electrons on the rod and move into solution as Zn2+ions:Zn(s) Zn2+(aq) + 2eThis process would result in an accumulation of negative charge on the zinc rodAlternatively, the Zn2+ions in solution could accept two electrons from the rod and move onto the rod to become Zn atoms: Zn2+(aq) + 2e Zn(s)This process would result in an accumulation of positive charge on the zinc rodIn both cases, apotential differenceis set up between the rod and the solutionThis is known as anelectrode potentialA similar electrode potential is set up if a copper rod is immersed in a solution containing copper ions (eg CuSO4), due to the following processes:Cu2+(aq) + 2e Cu(s) reduction (rod becomes positive)Cu(s) Cu2+(aq) + 2e oxidation (rod becomes negative)Note that a chemical reaction is not taking place there is simply a potential difference between the rod and the solutionCreating an EMFElectrons flow through the external circuit from the anode (where oxidation occurs) to the cathode (where reduction occurs)If two different electrodes are connected, the potential difference between the two electrodes will cause a current to flow between themThus an electromotive force (EMF)is established and the system can generate electrical energyA typical electrochemical cell can be made by combining a zinc electrode in a solution of zinc sulfate with a copper electrode in a solution of copper sulfateElectrochemical cellThe zinc-copper voltaic cell (also known as the Daniell Cell)The circuit must be completed by allowing ions to flow from one solution to the otherThis is achieved by means of asalt bridgeThis is often a piece of filter paper saturated with a solution of an inert electrolytesuch as KNO3 (aq)In the salt bridge, negative ions (anions) migrate toward the anode, and positive ions (cations) migrate toward the cathode to balance the charges in each half-cellThe EMF can be measured using a voltmeterVoltmeters have a high resistance so that they do not divert much current from the main circuitThe two half cells are said to bein series as the same current is flowing through both cellsThe combination of two electrodes in this way is known as a voltaic cell and can be used to generate electricityConventional representation of cellsChemists use a type of shorthand convention to represent electrochemical cellsIn this convention:A solid vertical (or slanted) line shows a phase boundary, which is an interface between a solid and a solutionA double vertical line (sometimes shown as dashed vertical lines) represents a salt bridgeAsalt bridge has mobile ions that complete the circuitPotassium chloride and potassium nitrate are commonly used to make the salt bridge as chlorides and nitrates are usually solubleThis should ensure that no precipitates form which can affect the equilibrium position of the half cellsThe substance with the highest oxidation state in each half-cell is drawn next to the salt bridgeThe cell potential difference is shown with the polarity of the right-hand electrodeThe cell convention for the zinc and copper cell would beZn (s)Zn2+ (aq) Cu2+ (aq)Cu (s) E cell = +1.10 VThis tells us the copper half-cell is more positive than the zinc half-cell so that electrons would flow from the zinc to the copperThe same cell can be written as:Cu (s)Cu2+ (aq) Zn2+ (aq)Zn (s) E cell = -1.10 VThe polarity of the right-hand half-cell is negative, so we can still tell that electrons flow from the zinc to the copper half-cellPage 3The typical reaction of a metal and an acid can be summarised asacid + metal salt + hydrogen2HCl (aq) + Zn (s) ZnCl2(aq) + H2(g)hydrochloric acid + zinc zinc chloride* + hydrogenH2SO4 (aq) + Fe (s) FeSO4 (aq) + H2(g)sulfuric acid + iron iron(II) sulfate* + hydrogen*zinc chloride and iron(II) sulfate are saltsA salt is an ionic compound formed when the hydrogen of an acid is replaced by a metal or another positive ionClearly, the extent of the reaction depends on thereactivityof the metal and thestrengthof the acidVery reactive metals would react dangerously with acids and these reactions are not usually carried outMetals low inreactivitydo not react at allFor instance, copper does not react with dilute acidsStronger acidswill reactmore vigorouslywith metals than weak acidsWhat signs of reaction would be expected to be different between the two?Faster reaction seen as:more effervescencethe metal dissolves fasterIonic equationsThe reactions of acids and metals can be written as ionic equations showing only the species that has changed in the reactionZinc reacts with hydrochloric acid to give a salt and hydrogen:2HCl (aq) + Zn (s) ZnCl2(aq) + H2(g)The ionic equation, including all species, is:2H+(aq)+ 2Cl(aq)+ Zn (s) Zn2+(aq)+ 2Cl (aq) +H2(g)The chloride ions are spectator ions and can be removed to give the full ionic equation:2H+(aq) + Zn (s) Zn2+(aq) + H2(g)The full ionic equation is made from 2 half-equations:2H+(aq) + 2e- H2(g)Zn (s) Zn2+(aq) + 2e- H+(aq) in HCl (aq) is being reduced to H2(+1 to 0)Zn (s)is being oxidised to Zn2+(0 to +2)Full equation2HCl (aq) + Zn (s) ZnCl2(aq) + H2(g)Ionic equation2H+(aq) + Zn (s) Zn2+(aq) + H2(g)2H+(aq)+ 2Cl(aq)+ Zn (s) Zn2+(aq)+ 2Cl (aq) +H2(g)Reducing agentZn (s)Zn is being oxidised to Zn2+(0 to +2)Oxidising agentH+(aq) in HCl (aq)H+is being reduced to H2(+1 to 0)The ability of a metal to act as a reducing agent depends on how easily it loses electronsThis list orders metals from strongest to weakest reducing agents based on their tendency to lose electrons and become oxidised:Magnesium (Mg)Aluminium (Al)Zinc (Zn)Iron (Fe)Lead (Pb)Hydrogen (H) (reference point)Copper (Cu)Silver (Ag)The metals at the top of the list are the strongest reducing agents They lose electrons most easily and are readily oxidisedThe metals at the bottom are the weakest reducing agents They lose electrons less easily and are not readily oxidisedThis order also helps predict displacement reactions More reactive metals displace less reactive metal ions from solutionPage 4What is the order of decreasing reactivity of the metals (most reactive first)?Zn (s) + Sn2+ (aq) Zn2+ (aq) + Sn (s)Cu (s) + Zn2+ (aq) No ReactionSn (s) + Cu2+ (aq) Sn2+ (aq) + Cu (s)Ag (s) + Cu2+ (aq) No ReactionA. Zn > Cu > Sn > AgB. Sn > Zn > Ag > CuC. Ag > Cu > Zn > SnD. Zn > Sn > Cu > AgAnswer:The correct option is D.The first reaction tells you that zinc is more reactive than tin (Zn > Sn):Zn (s) + Sn2+ (aq) Zn2+ (aq) + Sn (s)The second reaction tells you that zinc is more reactive than copper (Zn > Cu):Cu (s) + Zn2+ (aq) No ReactionThe third reaction tells you that tin is more reactive than copper (Sn > Cu):Sn (s) + Cu2+ (aq) Sn2+ (aq) + Cu (s)The fourth reaction tells you that copper is more reactive than silver (Cu > Ag):Ag (s) + Cu2+ (aq) No ReactionPage 5Oxidation numbers can be used to balance chemical equationsGo through these steps to balance a redox equation:Write the unbalanced equation and identify the atoms which change in ox. no.Deduce the oxidation number changesBalance the oxidation number changesBalance the chargesBalance the atomsManganate(VII) ions (MnO4-) react with Fe2+ ions in the presence of acid (H+) to form Mn2+ ions, Fe3+ ions and water. Write the overall redox equation for the reactionAnswer:Write the unbalanced equation and identify the atoms which change in oxidation numberDeduce the oxidation number changesBalance the oxidation number changesBalance the chargesBalance the atomsIn titrations, the concentration of a solution is determined by titrating with a solution of known concentration.In redox titrations, anoxidising agentis titrated against areducing agentElectrons are transferred from one species to the otherIndicatorsare sometimes used to show the endpoint of thetitrationHowever, mosttransition metal ionsnaturally change colour when changing theoxidation stateThere are two commonredox titrationsyou should know about:Manganate(VII) titrationsIodine-thiosulfate titrationsA redox reaction occurs between acidified manganate(VII) ions and iron(II) ions:MnO4(aq) + 8H+(aq) + 5Fe2+(aq) Mn2+(aq) + 5Fe3+(aq) + 4H2O (l)This reaction needs no indicator as the manganate(VII) is a strong purple colour which disappears at the endpoint, so the titration is self-indicatingThis reaction is often used for the analysis of iron for example in iron tablets (health supplements)Iodine-thiosulfate titrationsA redox reaction occurs between iodine and thiosulfate ions:2S2O32(aq) + I2(aq) 2I(aq) + S4O62(aq)The light brown/yellow colour of the iodine turns paler as it is converted to colourless iodide ionsWhen the solution is a straw colour,starchis added to clarify the endpointThe solution turns blue/black until all the iodine reacts, at which point the colour disappears.This titration can be used to determine the concentration of anoxidising agent, whichoxidisesiodide ions to iodine moleculesThe amount of iodine is determined fromtitrationagainst a known quantity of sodium thiosulfate solutionThis reaction can be used for the analysis of chlorine in bleachA health supplement tablet containing iron(II)sulfate was analysed by titration. A tablet weighing 2.25 g was dissolved in dilute sulfuric acid and titrated against 0.100 mol dm-3KMnO4.The titration required 26.50 cm3 for a complete reaction. Calculate the percentage by mass of iron in the table.Answer:Write the balanced equation for the reactionoxidation: Fe2+(aq) Fe3+(aq) +e-reduction: MnO4-(aq) + 8H+(aq) + 5e- Mn2+(aq) + 4H2O (l)overall:MnO4-(aq) + 8H+(aq) + 5Fe2+(aq) Mn2+(aq) + 4H2O (l) + 5Fe3+(aq)Determine the amount of MnO4-used in the titrationmoles of MnO4-= 0.0265 dm3x 0.100 mol dm-3=0.00265 molDetermine the amount of iron in the reactionFrom the equation for the reaction, we know the reacting ratioMnO4-:Fe2+= 1: 5 moles ofFe2+=0.00265 mol MnO4-x 5 =0.01325 molConvert moles into the mass of ironMass of iron =0.01325 mol x 55.85 gmol-1=0.740 gFind the percentage of iron in the tablet % Fe in the tablet = (0.740/ 2.25) x 100 =32.9%Did this page help you? The article provides an overview of secondary cell, explaining its definition, types, and functionality, including Lead Acid, Nickel-Cadmium (NiCd), and Nickel Metal Hydride (NiMH) batteries. It discusses their construction, recharging processes, advantages, and safety aspects, as well as their applications in fields like automotive, electronics, and hybrid vehicles. Secondary CellA secondary cell can be recharged or restored. The chemical reaction that occurs on discharge may be reversed by forcing a current through the battery in the opposite direction. This charging current must be supplied from another source, which can be a generator or a power supply.Figure 1 shows one type of battery charger used for recharging automobile and motorcycle batteries. An alternating current, which will be studied in a later chapter, must be rectified to a direct current for charging the battery.Figure 1. This type of charger is called a trickle charger. 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How a lead-acid cell works. (ESB Brands, Inc.)The electrolyte of a fully charged battery is a solution of sulfuric acid and water. The weight of a pure sulfuric acid is 1.835 times heavier than water. This is called its specific gravity.A Lesson in Safety:During the charging process of a storage battery, highly explosive hydrogen gas may be present. Do not smoke or light matches near charging batteries. Charge only in a well-ventilated room. Batteries should be first connected to the charger before the power is applied. Otherwise, the sparks made during connection might ignite the hydrogen gas and cause an explosion.Specific gravity is the weight of a liquid as it compares to water. The specific gravity of water is 1.000. The acid and water mixture in a fully charged battery has a specific gravity of approximately 1.300 or less.As the electrolyte changes to water when the cell discharges, the specific gravity becomes approximately 1.100 to 1.150. Therefore, the specific gravity of the electrolyte can be used to determine the state of charge of a cell.The instrument used to measure the specific gravity is a hydrometer. The principle of the hydrometer is based on Archimedes principle in physics.This principle states that a floating body will displace an amount of liquid equal to its own weight.If the cell is in a fully charged state, the electrolyte liquid is heavier, so the float in the hydrometer will not sink as far. The distance that the float does sink is calibrated in specific gravity on the scale. This can be read as the state of charge of the cell.CautionExpensive storage batteries may be destroyed by excessive vibration and rough handling. Chemicals may break off from the plates and cause internal short circuits and dead cells. Handle a battery gently and be sure it is securely clamped and bolted in your car.In the 12-volt automotive battery, six lead-acid cells are placed in a molded hard rubber case. Each cell has its own compartment.At the bottom of each compartment space, or sediment chamber is provided. This is where particles of chemicals broken from the plates due to chemical action or vibration can collect. Otherwise, these particles would short out the plates and make a dead cell. The individual cells are connected in series by lead alloy connectors.CautionAutomotive batteries contain large amounts of lead. Consequently, they should never be disposed of in landfills. Stores that sell automotive batteries are required by law to accept old batteries for recycling.Nickel-Cadmium cellThe nickel-cadmium cell is a rechargeable dry cell. Basically, these are nickel-cadmium alkaline batteries with paste rather than liquid for the electrolyte.The ability to be recharged is just one of their advantages. Other advantages include long life, high efficiency, compactness, and lightweight.The nickel-cadmium cell produces a high discharge current due to its low internal resistance. Other uses include the powering of small radios, burglar alarm systems, camera flashes, and aircraft instruments.One type of nickel-cadmium cell uses positive and negative plates, a separator, alkaline electrolyte, a metal case, and a sealing plate with a self-resealing safety vent. It is shown in Figure 3.The positive plate of this battery is a porous, powdered nickel base plate. It is filled with nickel hydroxide.The negative plate is a punched plate of thin steel, coated with cadmium active material. The separator is made of a polyamide fiber. For high-temperature uses, it is made of a nonwoven polypropylene fiber.The positive plate, separator, and negative plate are pressed together, wound into a coil, and inserted in the metal case.Figure 3. Construction of a nickel-cadmium cell. (Panasonic Battery Sales Division)The electrolyte is an alkaline aqueous solution. It is totally absorbed into the plate and separator.The metal case is constructed of nickel-plated steel. It is welded on the inside to the negative plate. It becomes the negative pole.The sealing plate uses a special liquid sealing agent to form a perfect seal. The positive plate is welded on the inside to the sealing plate. It becomes the positive pole.The self-resealing safety vent permits the discharge of gas in the event of an abnormal increase of internal pressure. This prevents against rupture or other damage.The vent is made of a special alkaline and oxidation resistant rubber. This ensures that operating pressure and safety features will be retained over a long period of time.The electromechanical processes of a nickel-cadmium alkaline cell are outlined below.\[\begin{align} & \begin{matrix} 2NiOOH & + & \begin{matrix} Cd & + & \begin{matrix} 2{{H}_{2}}O & \leftrightarrow & \begin{matrix} 2Ni{{\left(OH \right)}_{2}} & \begin{matrix} + & Cd{{\left(OH \right)}_{2}} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\& \begin{matrix} Positive & {} & \begin{matrix} Negative & Electrolyte & \begin{matrix} Positive & {} & \begin{matrix} Negative & \begin{matrix} {} & {} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{matrix} \\\end{align}\]In this process, charging and discharging are reversed in a very efficient manner. The electrical energy used during discharge is regained during recharge. During the final charging stage, an oxygen gas is created with the reaction occurring at the positive.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} 4O{{H}^{-}} & \to & {{O}_{2}}\uparrow \\\end{matrix} & + & 2{{H}_{2}}O & + \\\end{matrix} & 4{{e}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Hydroxide & Oxygen & Water & Electrons \\\end{matrix} \\\end{align}\]This oxygen passes through the separator to the negative. After this, an absorption reaction takes place at the negative and absorption occurs.\[\begin{align} & \begin{matrix} \begin{matrix} \begin{matrix} {{O}_{2}} & + & 2{{H}_{2}}O \\\end{matrix} & + & 4{{e}^{-}} & \to \\\end{matrix} & 4O{{H}^{-}} & {} & {} \\\end{matrix} \\& \begin{matrix} Oxygen & Water & Electrons & Hydroxide-Ions \\\end{matrix} \\\end{align}\]Nickel Metal Hydride CellNickel metal hydride (NiMH) is a rechargeable battery very similar to the NiCad battery.The NiMH battery uses nickel for the positive cathode and a hydrogen-absorbing alloy for the negative anode rather than cadmium, which is found in the NiCad battery.The fact that NiMH batteries do not use cadmium makes them environmentally friendly.Hydrogen-absorbing alloys are made from combinations of nickel and iron (Fe), magnesium (Mg), and lanthanum (La). The alloys can absorb large volumes of hydrogen equal to approximately 1000 times their weight without an increase in volume. This means the batteries can be sealed without the danger of explosion caused by the expansion of materials.A NiMH battery can have two to three times the storage capacity of a NiCad battery of equal size. This has made it an excellent battery for hybrid vehicles and portable computer applications.The discharge voltage level is 1.2 volts, which is the same as for NiCad batteries. The NiMH battery can be recharged over 500 times. The combined characteristics of the NiMH makes it an ideal replacement for existing NiCad battery applications.NiMH batteries should never be completely discharged. If they are, one or more of the cells can reverse polarity, which will result in permanent damage to the battery.Electronic devices that use NiMH batteries typically have a special circuit designed to detect low voltage levels and then disconnect the battery circuit before damage can occur.Secondary Cell Key TakeawaysThe secondary cell plays a vital role in various applications due to its ability to be recharged and reused. Examples of secondary cells, such as the lead-acid, nickel-cadmium (NiCd), and nickel-metal hydride (NiMH) batteries, provide energy solutions across multiple industries. The lead-acid secondary cell is widely used in automotive batteries, while the nickel-cadmium secondary cell is common in smaller electronic devices. The nickel-metal hydride secondary cell, with its higher energy density and environmental benefits, is increasingly found in hybrid vehicles and advanced electronics. The ability of secondary cells to be recharged makes them an essential part of modern technology, offering both economic and environmental advantages by reducing waste. Their significance will only grow as technology continues to advance, ensuring they remain a cornerstone in energy storage solutions.

What is secondary cell give one example. What is primary and secondary cell explain with example. What is secondary cell give an example. What is secondary cell give an example class 12. What is secondary cell. What is primary and secondary cell give example. What is primary cell and secondary cell with example.