

## Primary batteries

Primary batteries, also known as disposable batteries. They are designed for single use and can't be recharged. They are commonly used in low drain devices such as remote controls, flash lights, smoke detectors as well as in high drain devices like cameras, toys and portable electronics.

Primary batteries typically use electro-chemical reactions that convert stored chemical energy into electrical energy. These batteries are usually made up of an anode (-ve electrode) and a cathode (+ve) and electrolyte that separates the two electrodes.

When the battery is connected to a circuit a chemical reaction occurs in the battery that produces a flow of electrons from the anode to the cathode, generating an electric current.

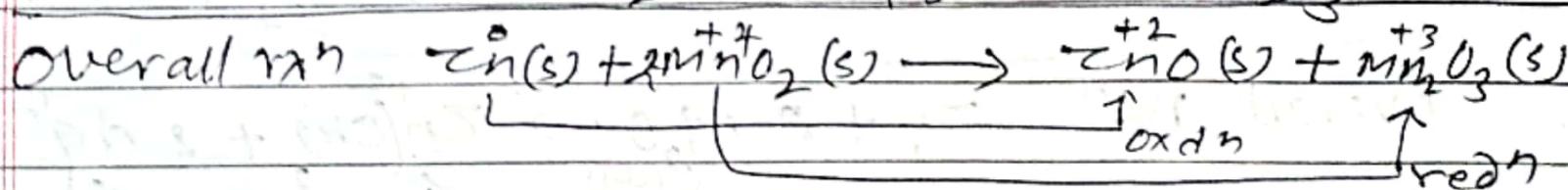
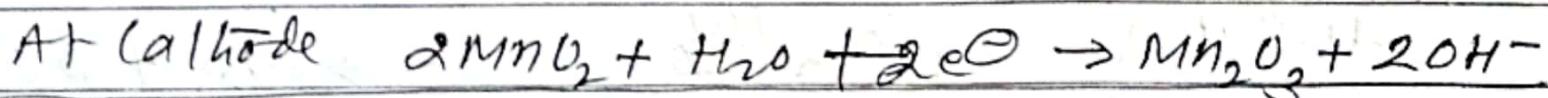
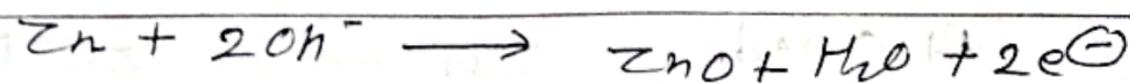
There are several types of primary batteries including alkaline, zinc-carbon, lithium and silver oxide batteries.

The rxns occurring in such batteries are irreversible electro-chem. rxns.

(i) In alkaline batteries Zn is used as

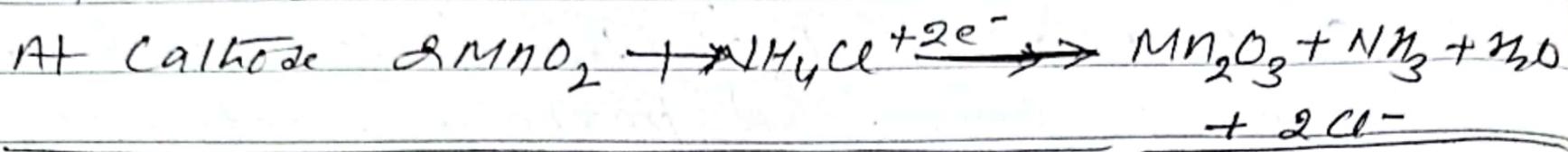
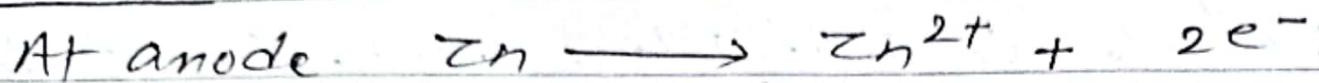
Anode &  $\text{MnO}_2$  as Cathode. The electrolyte used is KOH or NaOH solution. The chemical reaction involved in this cell are - :

At anode

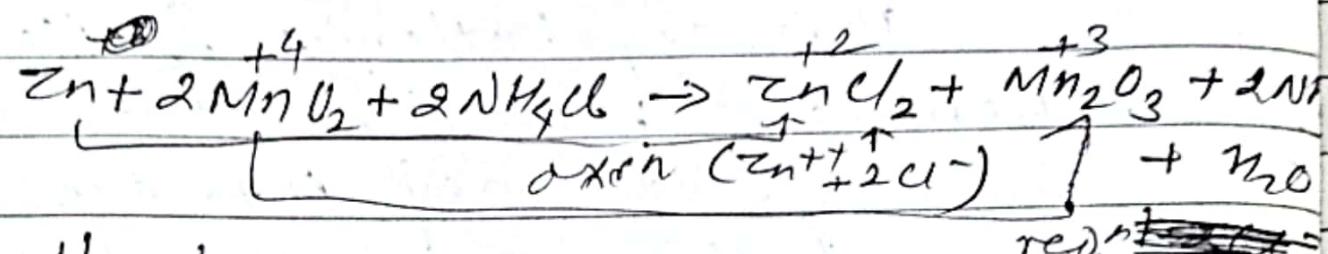


(i) Zinc-Carbon batteries  $\rightarrow$  In this type of battery (dry cell battery), Zn is used as anode & ~~Ag<sub>2</sub>O~~ Carbon as cathode. The electrolyte used is NH<sub>4</sub>Cl or ZnCl<sub>2</sub> solution.

Rxns involved



Overall rxn

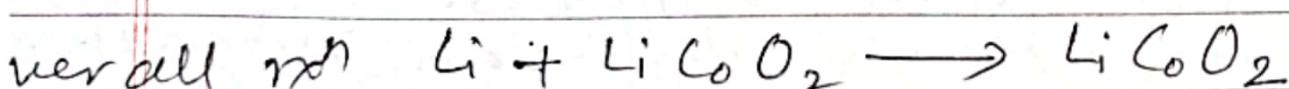
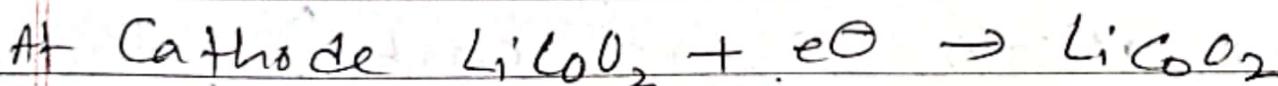
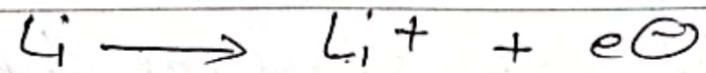


(ii) Lithium batteries

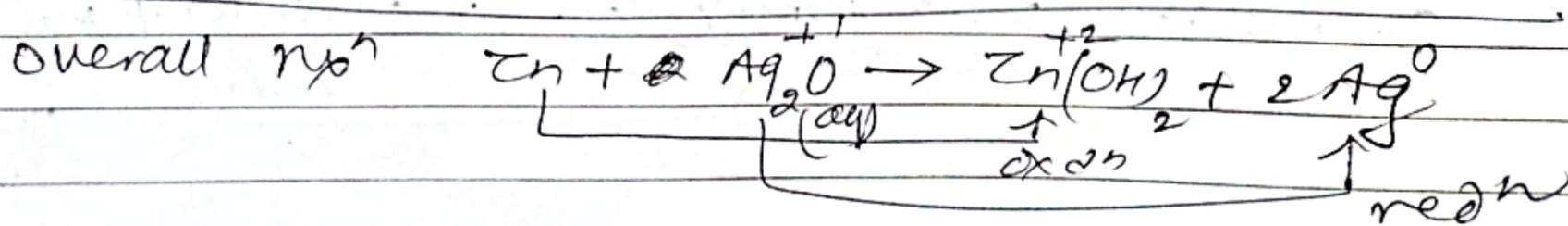
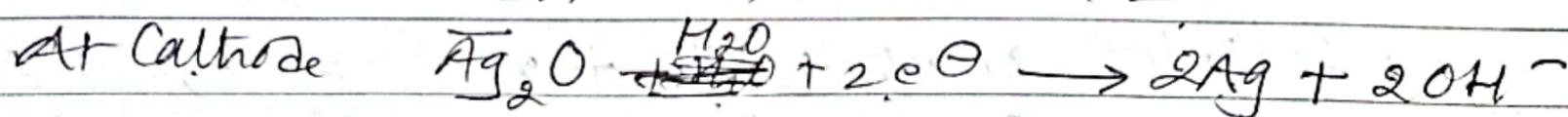
It is a type of primary battery that uses lithium metal as anode and compound of lithium like LiCoO<sub>2</sub> or LiFePO<sub>4</sub> as cathode. The electrolyte used is lithium salt in an organic solvent.

Rxns involved

At anode



(iii) Silver oxide batteries.  $\rightarrow$  It consists of Zn ~~anode~~ anode & Ag<sub>2</sub>O as cathode. Electrolytes used is either KOH or NaOH



## Secondary batteries.

A secondary battery, also known as rechargeable battery that can be charged and discharged multiple times, making it more sustainable and cost effective option compared to primary batteries. They are widely used in ~~batteries~~ portable electronic devices, electric vehicles, and renewable energy systems.

The chemical reactions that occur in a secondary battery are reversible. Which means that the reaction products can be converted back into reactants by applying an external electrical current. When a secondary battery is charged the electrical energy from an external source is used to drive the reaction in opposite direction converting the products back into reactants. Due to this battery can resume its function multiple times, making it more environmentally friendly & cost effective.

Examples of secondary batteries are lithium ion battery, Ni-Cd battery, lead acid battery.

## Lithium ion battery:-

Lithium ion batteries are the secondary batteries which are widely used in portable electronic devices like Smart phones, laptops. They have high energy density which means they can store a lot of energy in a small space. They have relatively long life span and can be charged & discharged hundreds of times before losing their capacity. This type of battery uses Li<sup>+</sup> ion as main charge carrier. The popularity of this type of battery is due to high energy density, long life span and low self discharge rate.

The basic structure of Li<sup>+</sup> ion battery includes three main components i.e. cathode, anode & electrolyte. The Cathode is made up of metal oxide [LiCoO<sub>2</sub>] while the anode is made up of Carbon or graphite. The electrolyte used ~~is~~ is lithium salt in organic solvent. A separator is used to prevent the anode & cathode from coming into contact which may cause short circuit.

During discharge, lithium ions move from Cathode to anode through electrolyte while electrons flow anode to Cathode through external circuit. This flow of e<sup>-</sup>s creates a flow of electrical energy. During charging the process is reversed i.e. Li<sup>+</sup> ions move from anode to Cathode & electrons from Cathode to anode.

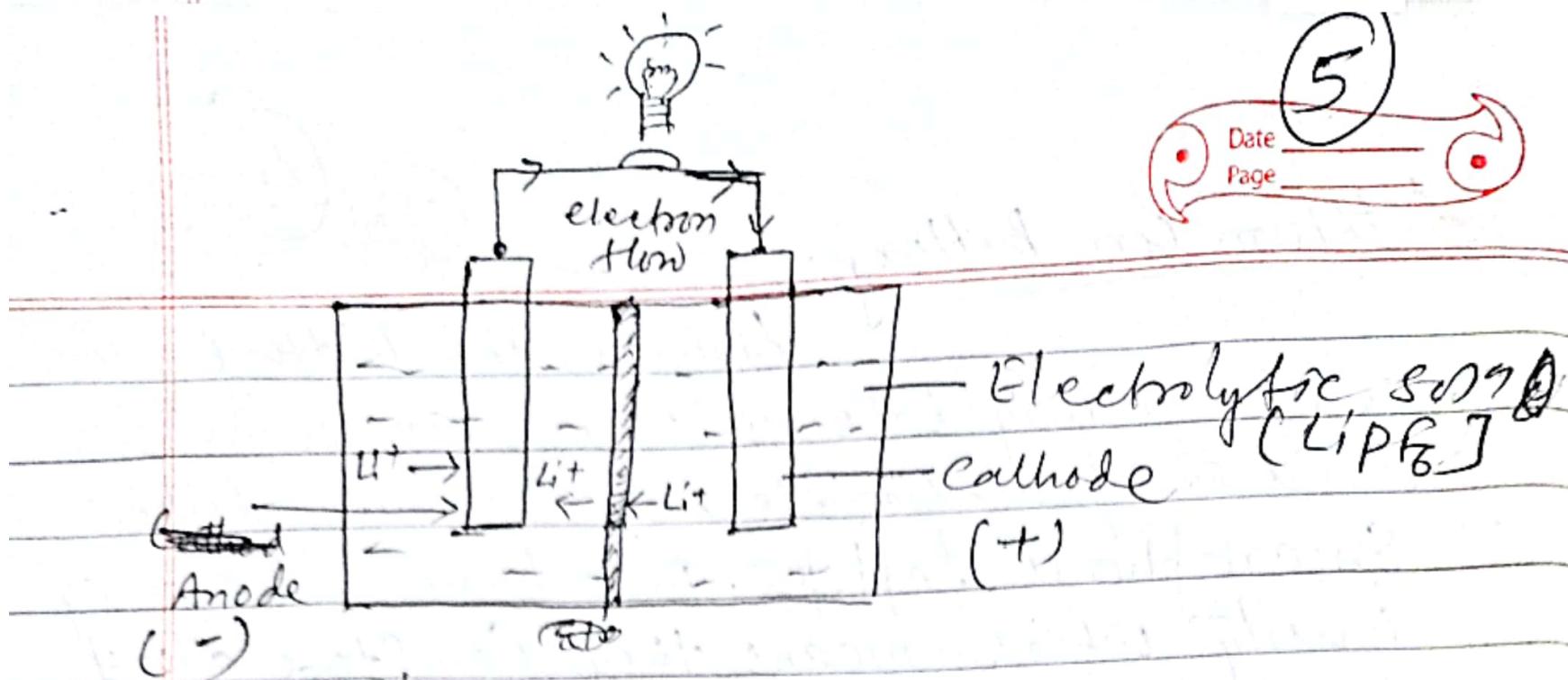
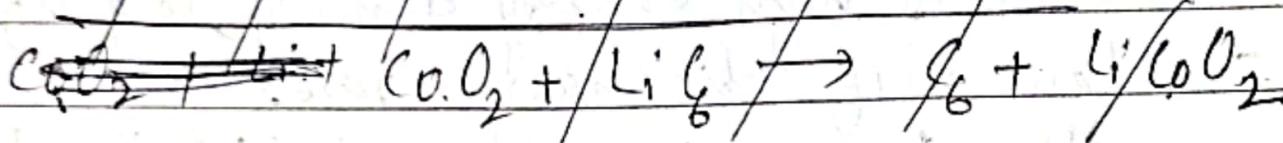
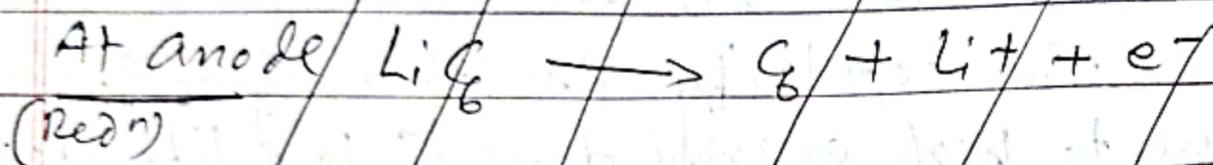
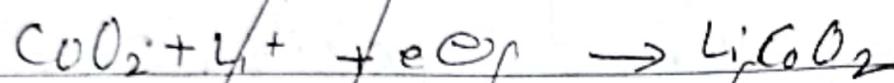


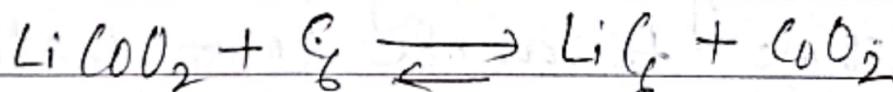
Fig. Li<sup>+</sup> ion battery

At Cathode (Red<sup>n</sup>)

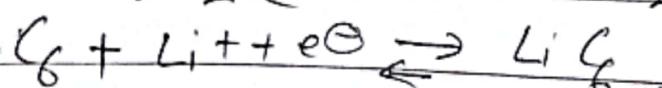
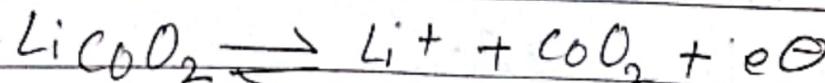


In lithium ion battery the rxn's that occurs during Charging and discharging involves the movement of Li<sup>+</sup> ion between two electrodes.

During discharging, a voltage is applied. Li<sup>+</sup> ions move from graphite electrode towards metal oxide electrode which generates electric current that can be used to power a device. The overall rxn involved during discharging is.



During charging a voltage is applied to the battery causing Li<sup>+</sup> to move in opposite direction i.e. from metal oxide electrode to graphite electrode. Overall rxn



## The overall Advantages of Li+ ion battery.

- ① High energy density - i.e. it can store more energy per unit weight or volume.
- ② Low self discharge rate - i.e. they can retain charge for longer period of time.
- ③ Long life cycle:- It can withstand a large number of charge & discharge cycle.
- ④ Light weight & compact :-
- ⑤ Fast charging
- ⑥ Low maintenance
- ⑦ Environmentally friendly.

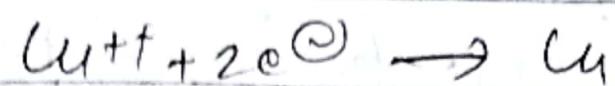
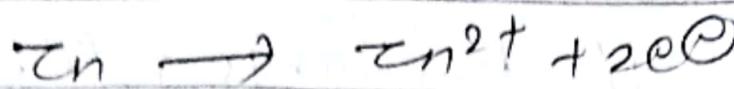
Disadvantages :- ① Limited life span i.e. 2-3 years or 300-500 charge cycles.

- ② High cost:- more expensive to manufacture than other types..
- ③ Safety concern:- They have been known to catch fire or explode, if they are damaged.
- ④ Environmental impacts:- metals like, Co, Li used here can harm the environment if not disposed properly.
- ⑤ Performance issues in extreme temperature:- They drop their voltage at too hot or too cold.

Zn-Cu battery :- This is a type battery that uses Zn-electrode as anode & Cu-electrode as cathode. The electrolyte used is aq. soln of  $\text{ZnSO}_4$ .

During discharge, Zn-atoms are oxidized at the anode, releasing electrons that

flow through an external circuit to the cathode, where they reduce copper ions to copper atoms.



This rxn generates about 1.1 volts, its energy density is relatively low. However it is ~~Adv~~ low costing & long life.

Applications :- used in low power devices like calculators, remote controls, emergency lighting and backup power systems.

oceanographic instruments

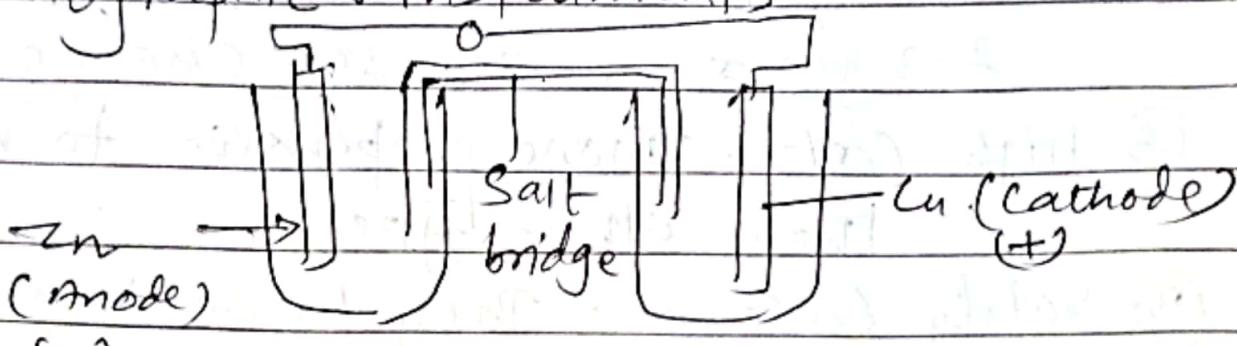
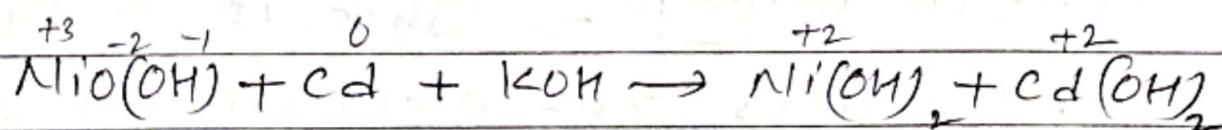


Fig Zn-Cu battery

Ni-cd battery :- it is a type of rechargeable battery that uses Nickel oxide hydroxide (cathode) and Cadmium as anode. The electrolyte used is aq. soln of KOH.

During discharge the nickel oxide hydroxide is oxidized at the cathode while Cd<sup>+</sup> is reduced



this rxn generates voltage of 1.2 volts.

Advantages :-

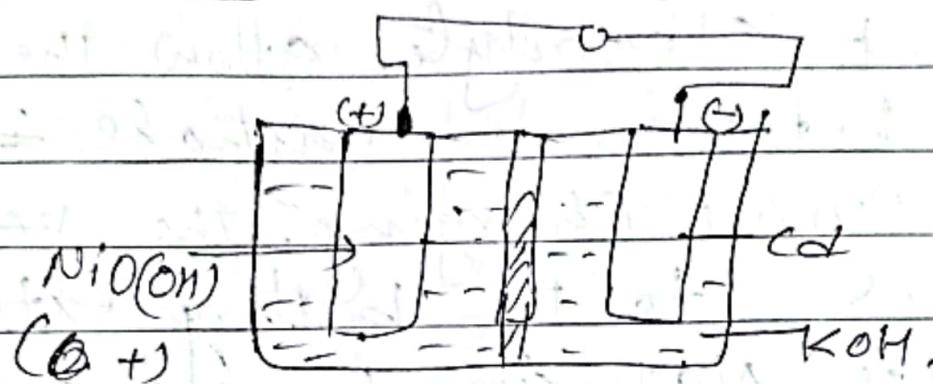
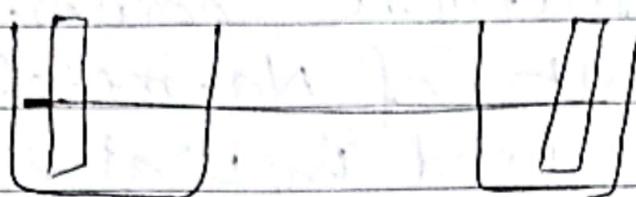
- i) High energy density
- ii) Can be recharge many times
- iii) Capable of delivering high currents, in low cost discharge rate

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W resistance to shock & vibration.

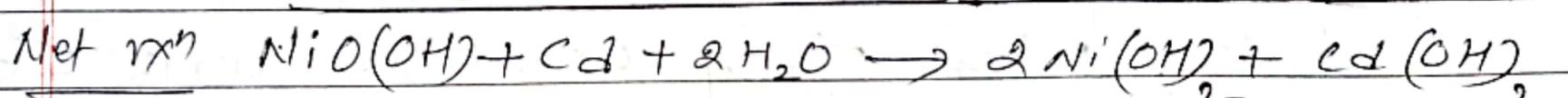
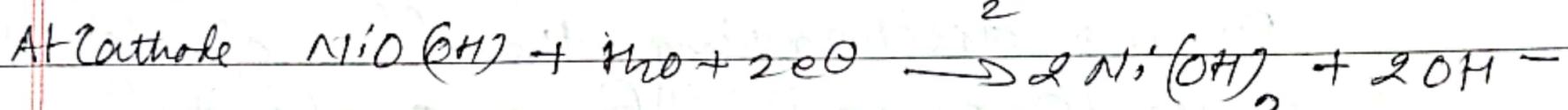
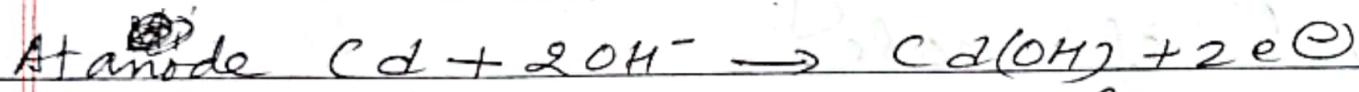
Application :- (1) Used in portable electronic devices.

(2) energy lighting, cordless power tools, backup power system, ~~Avea~~ aviation & aerospace applications.

However use of this battery has environmental concern as Cd is used here which is toxic.



Alkaline Ni-Cd battery.



Sodium Batteries :- These are a type of rechargeable battery that use sodium ions as the charge carriers. They are similar in many ways to Li+ ion batteries but they use sodium instead of lithium, which make them potentially less expensive & more sustainable.

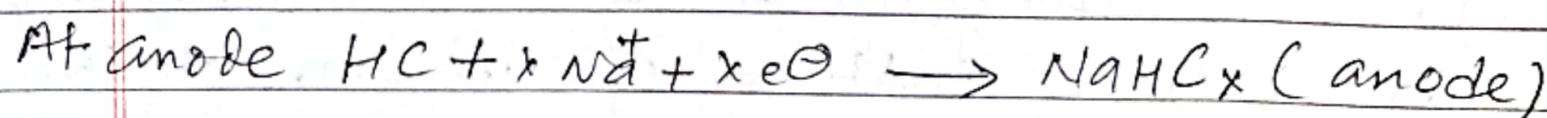
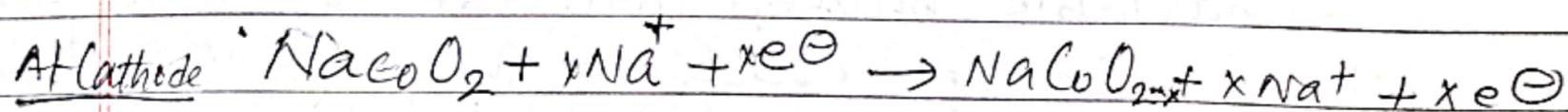
Sodium batteries have a construction similarly as other rechargeable battery. It consists of two electrodes separated by electrolyte.

The Cathode in such batteries is typically made from a material that can accept sodium ion like sodium cobalt oxide ( $\text{NaCoO}_2$ ) or sodium Nickel manganese dioxide [ $\text{Na(NiMn)}\text{O}_2$ ] and anode is usually made from a material that can release  $\text{Na}^+$  ions, such as hard carbon (mesocarbon microbeads) or porous metallic Sodium. The electrolyte used is salt of Na-metal like NaCl or NaON dissolved in water or organic solvent. Electrolyte allow the flow of ions between Cathode  $\xrightarrow{\text{and}}$  anode.

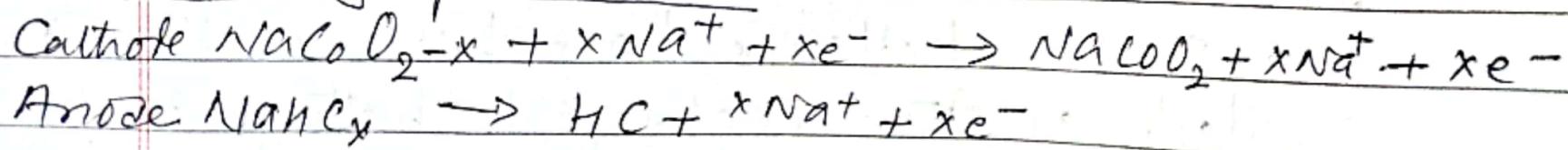
During charging, the volt voltage is applied to the battery externally, which causes  $\text{Na}^+$  ion to move from Cathode to anode, where they are stored in the material of anode.

During discharging the flow of  $\text{Na}^+$  ions occurs from anode to Cathode, where they combine with  $e^-$  to produce a flow of electric current.

### Charging reaction



### Discharging reaction

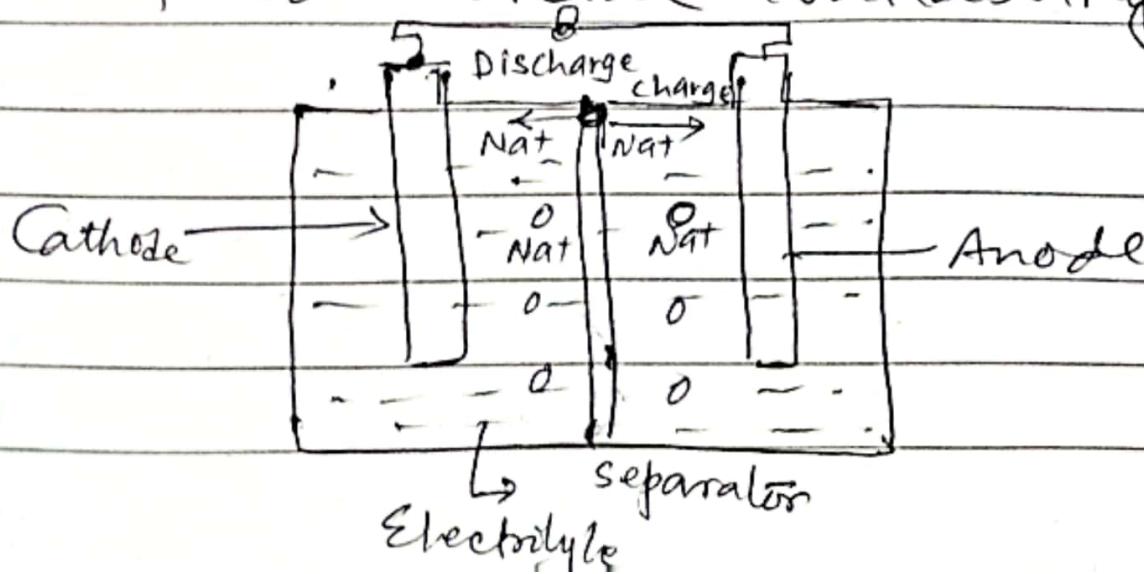


## Applications of sodium battery

- ① It is used in energy storage system to store renewable energy such as solar, wind energy.
- ② Sodium batteries have high energy density which makes it suitable for using in electric vehicles.
- ③ It is used in portable electronic devices like Smart phone, tablets and laptop etc.
- ④ They can be used for to stabilize the power grid & also used as backup power when electricity supply is off.
- ⑤ It has industrial applications like remote mining operation or oil & gas drilling etc.

## Limitations

- ① Lower energy density than Li-ion batteries,
- ② It has limited cycle life.
- ③ Limited availability of materials used in the battery, like NaNi<sub>3</sub>.
- ④ Sodium metal is used in the battery it's highly reactive so, handling it is riskies.
- ⑤ They are at early stage of development so has lack of commercial availability.



# Neoprene

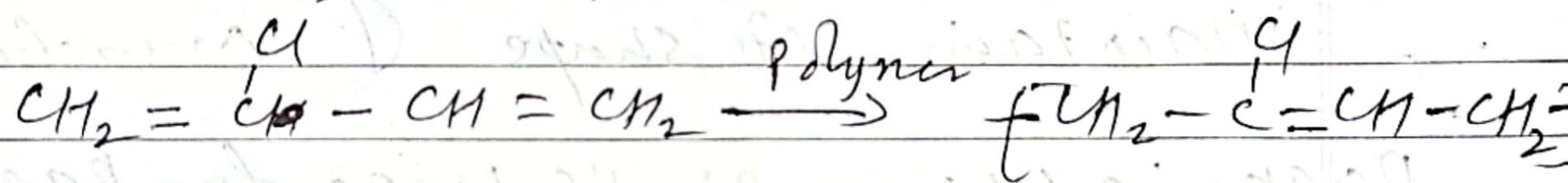
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Neoprene <sup>rubber</sup> is a trade name for polychloroprene  
 $\left[-\text{CH}_2-\overset{\text{Cl}}{\underset{\text{C}}{\text{C}}}=\text{CH}-\text{CH}_2\right]$  i.e. Polymer of Chloroprene

$\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$  which is a versatile synthetic rubber. It is produced by <sup>free radical</sup> polymerization of chloroprene.

The polymer chips of neoprene are melted and mixed with various foaming agents and carbon pigments before being baked until the mixture expand to create sheets of neoprene. Neoprene is suitable for applications that require a general purpose material that is durable, water proof, thermally stable  $-40^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$  & resistance to chemicals and corrosive mediums.



Polychloroprene  
(Neoprene)

## Applications

i) For making wire & cable insulation

ii) To make belts.

iii) Springs

iv) Flexible mounts.

v) Gaskets, hoses & corrosion resistance coatings

vi) Adhesives.

vii) laptop sleeves (G1+) Prepare

viii) orthopedic braces (wrist, knee, etc)

ix) liquid & sheet supports used as elastomer to support heavy loads.

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Marine uses -

① Being water proof it is used for making & diving suits, N<sub>2</sub> is added to provide buoyancy

Automotive uses

- Elastomeric fan belts.
- It's resistance to abrasion, tear, solvent, oil & weather, as well as fire proof hence used to make parts of automotive.

Medical →

Supports &  
to make orthopedic braces  
like hand, knee, & elbow support  
due to its flexibility & ability to  
maintain its shape over time.

Packing uses - It is used for packing

Since neoprene is a soft-rubber by nature, its strong padding and reinforcement material for some delicate applications.