

CHEMICAL EFFECTS Of ELECTRIC CURRENT



The chemical changes take place when an electric current passes through ionic solutions.

CONDUCTIVITY IN SOLIDS

CONDUCTORS

Metals are the good conductors of electricity.

In a metal atom, electrons are loosely bound to the atom.

Electrons which are loosely bound to the atoms can move easily in the solid piece of metal.

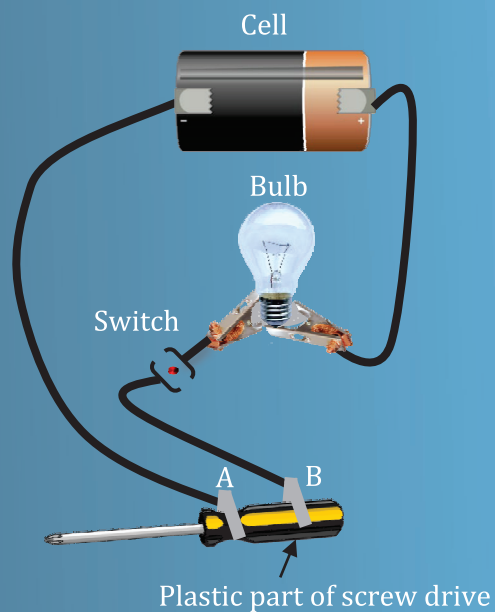
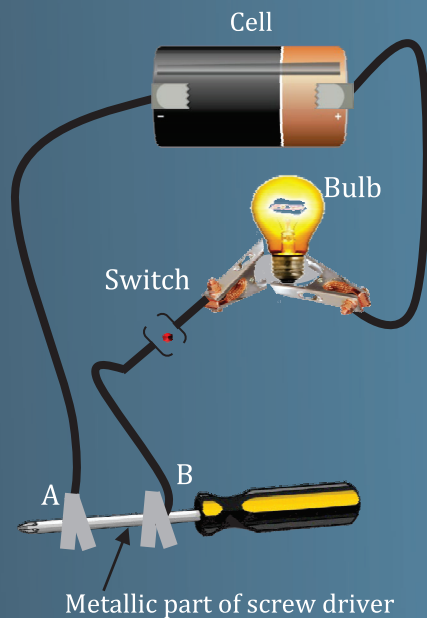
These electrons are called 'free electrons' or 'conduction electrons'.

INSULATORS

Insulators are poor conductors of electricity.

In an insulator, the electrons are bound tightly in the atoms

In Insulators electrons cannot move easily.



LED

- You may use an 'light emitting diode (LED)' in place of the electric bulb in the tester that is used in.
- LED glows even when a weak electric current flow through it.
- There are two wires (called leads) attached to an LED.

One lead is slightly longer than the other.

- The longer lead is always connected to the positive terminal of the cell (or battery).

The shorter lead is connected to the negative terminal of the cell (or battery).



CONDUCTIVITY IN LIQUIDS

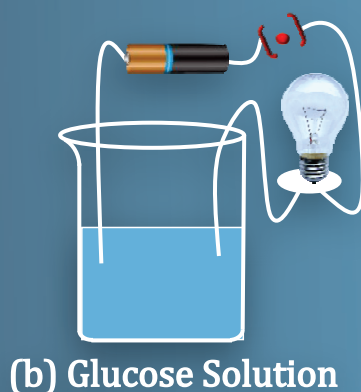
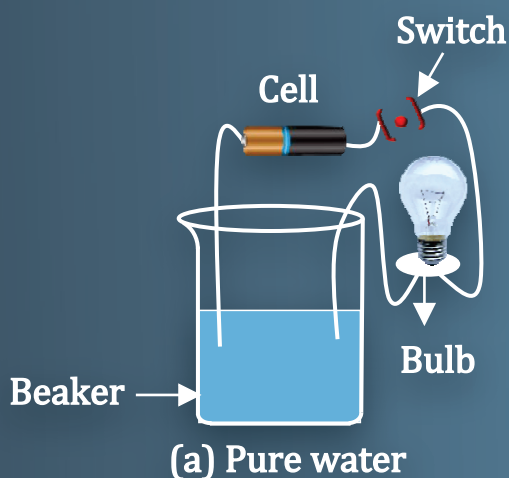
An electric current flow due to movement of charged particles, they may be electrons or ions.

The positive and negative ions are free to move thus, liquids containing ions can conduct electricity.

Ions are charged atoms or electrified atoms which may contain positive or negative charges.

A neutral atom has no net charge on it.

Negative ions are called 'anions' while positive ions are called 'cations'.



CHEMICAL EFFECTS OF ELECTRIC CURRENT

The chemical changes that take place when an electric current passes through ionic solutions is called 'chemical effect of electric current'.

ELECTROLYTES

Electrolytes are bad conductors of electricity in solid states, but they become good conductors in their molten state or in solution.

STRONG ELECTROLYTES

The electrolytes which are almost completely ionised when dissolved in solvent like water are called 'strong electrolytes.'

e.g.

HNO_3 , HCl , KOH , NaOH ,
 K_2SO_4 , NaCl , etc.

WEAK ELECTROLYTES

The electrolytes which are not completely ionised when dissolved in solvent like water are called 'weak electrolytes'

e.g.

CH_3COOH , H_3PO_4 ,
 H_3BO_3 , NH_4OH , etc.

NEUTRALISATION

Neutralization is a chemical reaction between an acid and a base that takes place in a water solution.



SALTS

A salt is a compound formed when the negative ions from an acid combine with the positive ions from a base.

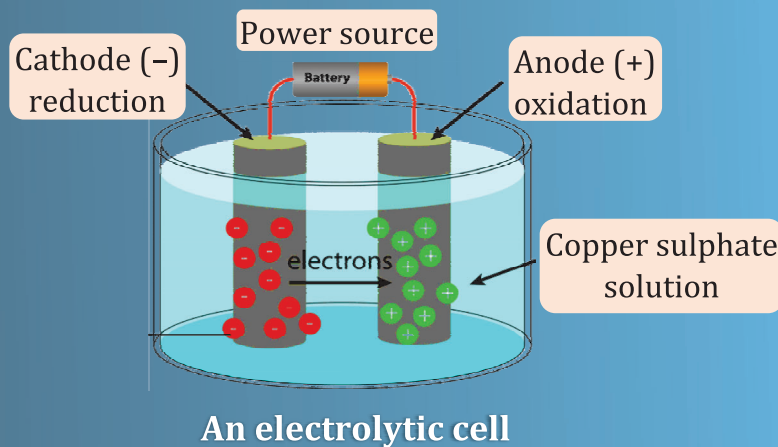
- Sodium chloride (NaCl), magnesium chloride [$\text{Mg}(\text{Cl})_2$], calcium chloride [$\text{Ca}(\text{Cl})_2$], copper sulphate [CuSO_4], silver nitrate [AgNO_3].

Solutes and solvents

- The solute is the substance that is being dissolved, while the solvent is the dissolving medium.

Electrolysis

- The production of a chemical reaction by passing an electric current through an electrolyte is called 'electrolysis'.



- At cathode, reduction of positive ion (cation) takes place and at anode, oxidation of negative ion (anion) takes place. Thus, in this way, a chemical change takes place by passing electric current through the electrolytic cell.
- The term oxidation means the loss of electrons by an atom or a molecule or an ion. The term reduction means the gain of electrons by an atom or a molecule or an ion.

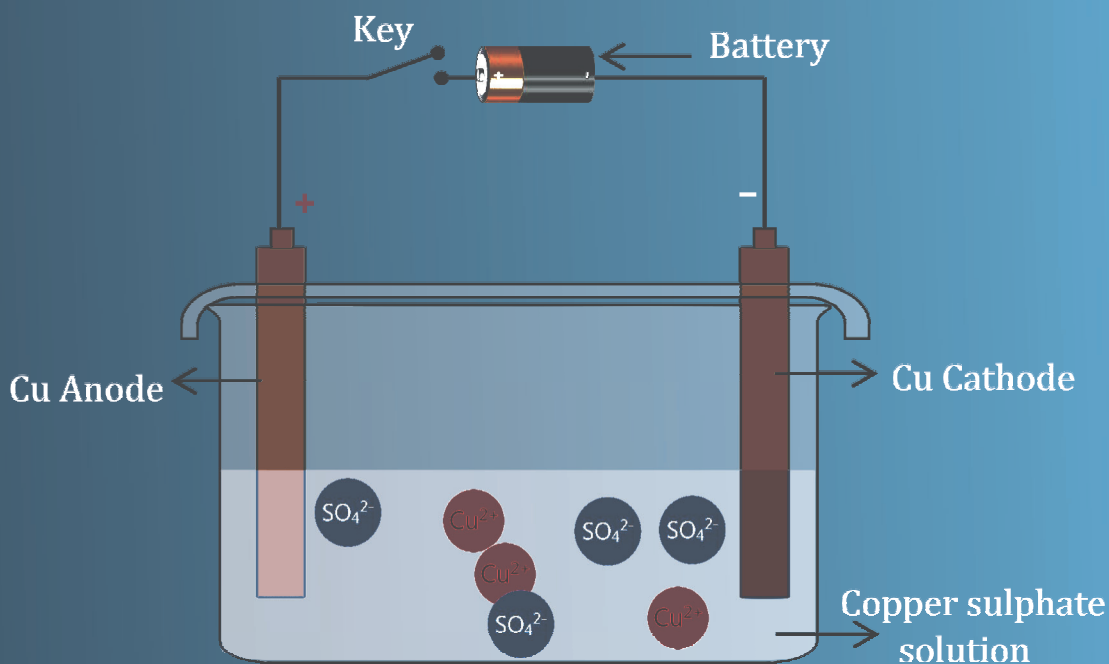


Electrolysis of copper sulphate solution construction

- It consists of an electrolytic cell with two copper electrodes (plates) partly immersed in an aqueous solution of CuSO_4 (electrolyte).

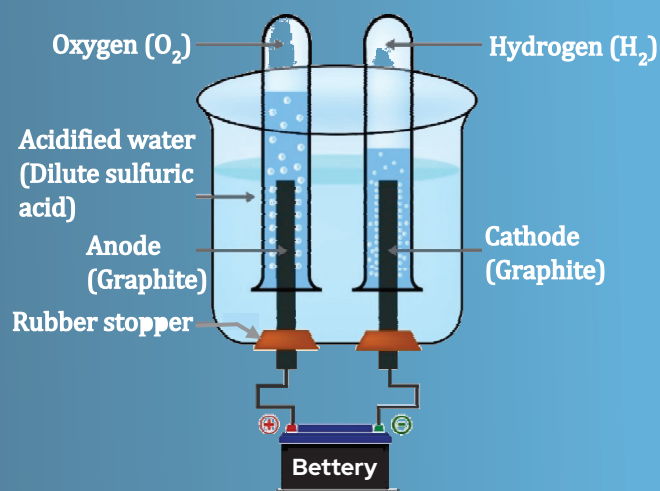
Working

- The electrolyte CuSO_4 is in the form of free Cu^{2+} ions (copper ion) and SO_4^{2-} ions (sulphate ions).
- A steady current is passed in the circuit with help of a battery. The electrons flow from the negative terminal of the battery to the cathode via connecting wire.
- Since the cathode is negatively charged, the positively charged Cu^{2+} ions move towards it. At cathode, the Cu^{2+} ions get reduced by incoming electrons from the external circuit. (Reduction of Cu)
- The Cu atoms so produced get deposited on the cathode.



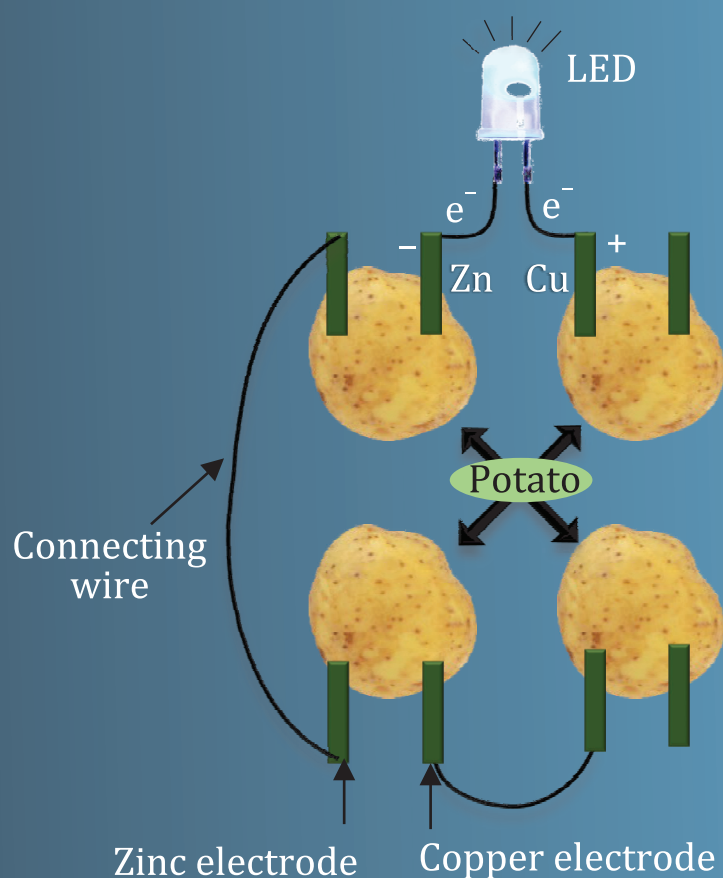
Electrolysis of water

The chemical reaction involved in electrolysis of water is given by,
Here, hydrogen is liberated at cathode by reduction while oxygen is liberated at anode by oxidation.



Why potato conducts electricity?

The potato does not participate directly in the reaction. It acts as an electrolyte due to presence of water, phosphoric acid (H₃PO₄), and some minerals containing calcium, iron, magnesium, potassium ions.



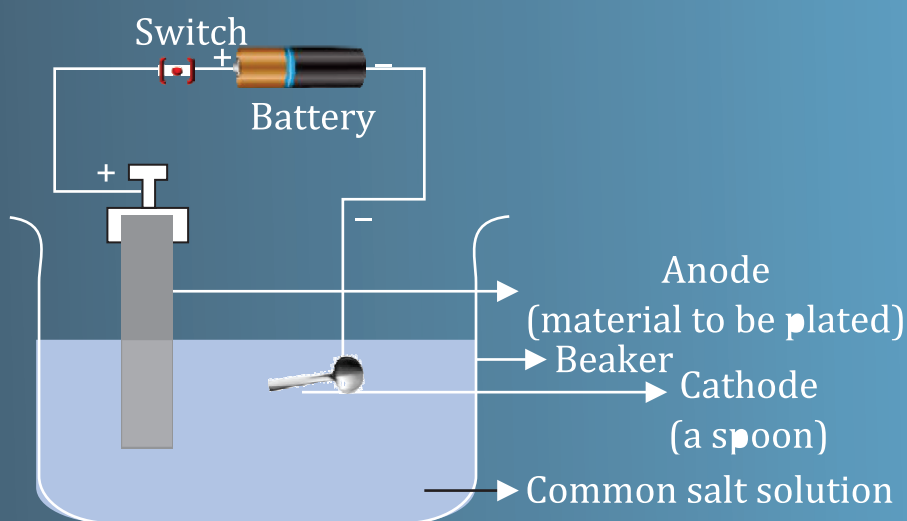
Electroplating

It is the most common application of electrolysis for coating of thin layer of metals like nickel, silver, gold, zinc, etc., on the surface of other metal or alloy.

The process of depositing a thin and uniform layer of a metal on any conducting surface is called 'electroplating'.

The conducting material to be electroplated is made 'cathode' and the metal whose coating is required on the cathode material is used as anode.

A soluble salt which contains ions of anode material is taken as electrolyte when the current is passed through the circuit.



Extraction of metals from ores

- ▶ Many metals are extracted from their ores using electrolysis.

Manufacture of compounds

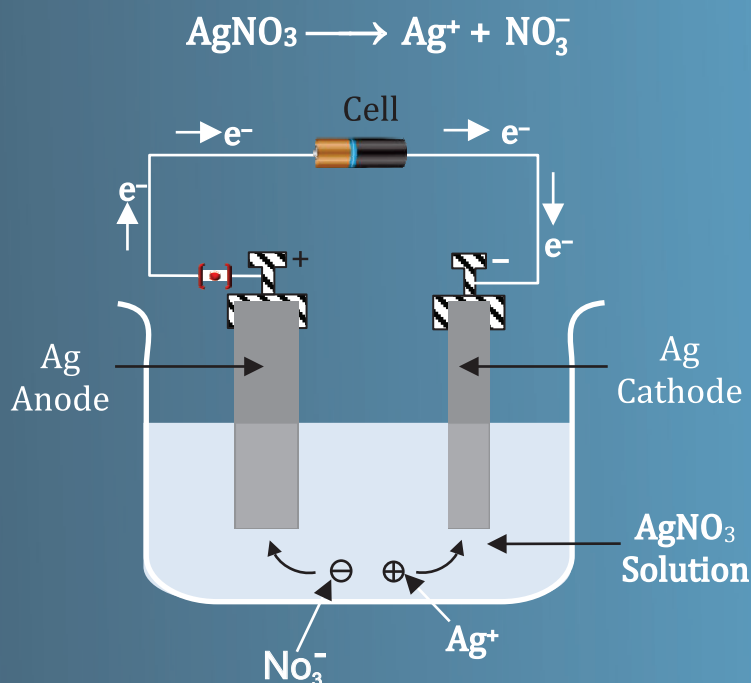
- ▶ NaOH is manufactured using electrolysis from NaCl solution.
- ▶ KOH is also manufactured from KCl solution using electrolysis

Purification of metals (refining of metals)

- ▶ In this process impure metals is used as anode and pure metallic strip is used as cathode. A soluble salt of pure metal is taken as electrolyte. On passing current, the impure metal anode dissolves but only the pure metal deposits on the cathode .

Electrolysis of silver nitrate solution

It takes place in an electrolytic cell with two silver electrodes (plates) partly immersed in an aqueous solution of silver nitrate (AgNO_3) (electrolyte). The Ag electrodes are connected to the two terminals of a battery (see figure). The positively charged electrode is called 'anode' and the negatively charged electrode is called 'cathode'. The electrolyte AgNO_3 is in the form of free Ag^+ ions (silver ion) and NO_3^- ions (nitrate ions).



(ii) At cathode : $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ (reduction)

The Ag atoms so produced get deposited on the cathode.

(iii) At anode : $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$ (oxidation)

The silver ions get into the solution, while released electrons flow back to the positive terminal of the battery via the connecting wire. The overall process results in deposition of silver at cathode and loss of equivalent amount of silver from anode. The concentration of AgNO_3 in solution remains same.