

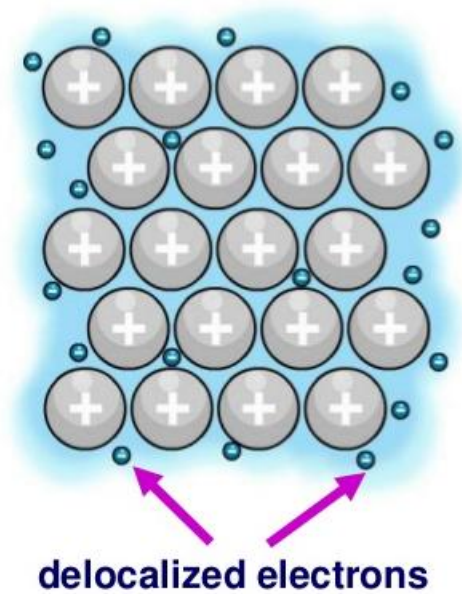
# Chemical Effects of Electric Current

## Conductors and insulators



**Figure 1 Conductors and Insulators of Electricity**

- A conductor is any material or substance that allows electricity to flow through it.
- An insulator is any substance or material that prevents the flow of electricity through it.
- Any substance can be called as a conductor of electricity if it allows movement of charges through it.
- The electrons of the conductors can flow freely (they are delocalized) and hence can take electric current through them.
- Insulators do not allow the flow of charges through them because their electrons are tightly packed with their particles.



**Figure 2 Delocalized Electrons in a Conductor**

- Some materials can allow a little flow of electricity through them and are called poor conductors of electricity.
- Some materials can allow the complete flow of electricity through them and are called good conductors of electricity.
- Every material may conduct electricity in certain situations. For example, air is a bad conductor of electricity but in case of thunderstorms and lightning it carries electric charges through it. Hence, materials are always classified as good and poor conductors of electricity rather than conductors and insulators.

### **Can liquids conduct electricity?**

- Not all liquids can conduct electricity. However, some of them can be regarded as good conductors of electricity while others as poor conductors of electricity.
- Water containing salts and minerals dissolved in it always conduct electricity.
- Distilled water which does not contain any salts cannot conduct electricity.
- Any solution of acids or bases can also conduct electricity.

Material under test	Good conductor/Poor conductor
Distilled water	Poor conductor
Tap water	Good conductor
Lemon juice	Good conductor
Vinegar	Poor conductor
Cooking Oils	Good conductor
Milk	Good conductor
Honey	Poor conductor
Soda compounds	Good conductor
Mercury	Good conductor
Fuels	Poor conductor

Figure 3 Liquids that are Poor and Good Conductors of Electricity

### How do liquids conduct electricity?

- Different substances when mixed in water and electricity is passed through them can break apart and form positive and negative particles or ions in the water.
- These ions can pass the electric current through them.
- The more is the number of ions in a liquid the better conductor it is of electricity.
- That is why distilled water is a poor conductor of electricity but salt water is a good conductor of electricity.
- However, many compounds do not form any ions on mixing them with water and therefore they are poor conductors of electricity such as sugar water, oil and alcohol.

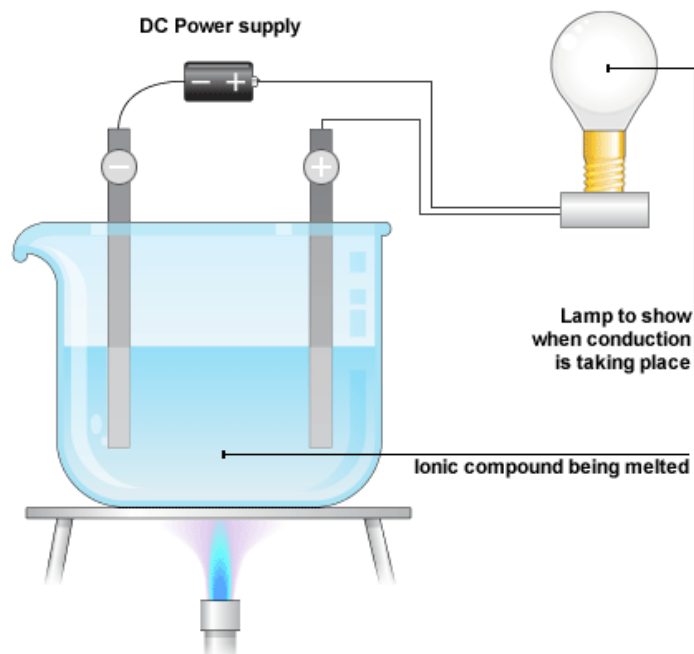


Figure 4 Set up to detect if a liquid can conduct electricity

## Why LED bulbs are more suitable for testing the electrical conductivity of liquids?

- The electric current often causes heating effect due to which the filament of the bulb gets heated up and glows.
- However, some liquids are capable of conducting electricity but they are weak conductors of electricity. Hence current passes through them but it is not that strong enough to heat up the filament. As a result, the filament would not light up in the case of such liquids.
- However, the LED bulbs can detect the flow of even a small amount of electric current as well. Hence, LED bulbs are suitable for testing the electrical conductivity of liquids.

## What is electrolysis?

The effect in which components of a compound get split due to passing an electric current through it is called electrolysis.

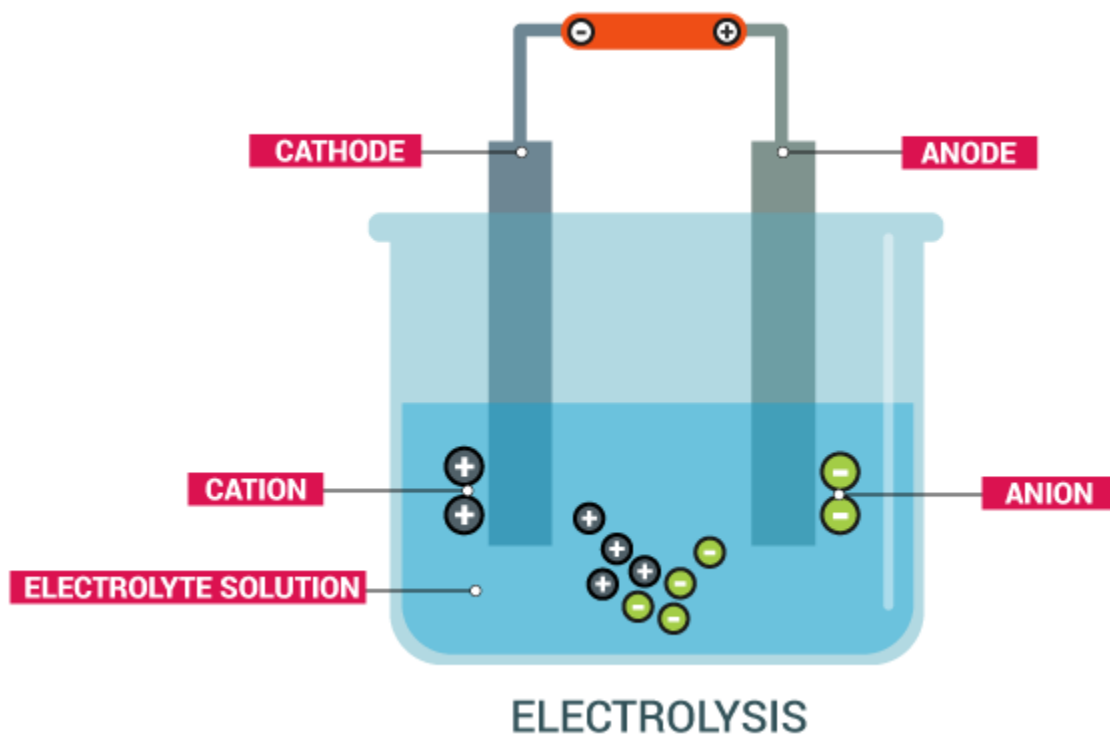


Figure 5 Electrolysis Process

## What is an electrode?

An electrode is a conductor of electricity that can carry electric current into non-metals and other poor conductors of electricity.

## What is an electrolyte?

A solution that breaks into its ions on passing electricity through it is called an electrolyte. Electrolytes are used in the process of electroplating.

## What are an anode and cathode?

The positively charged electrode is called anode and the negatively charged electrode is called cathode.

## What are anions and cations?

An anion is a negatively charged ion and a cation is a positively charged ion.

## Effects of an electric current

- **Heating effect:** electric current causes heating of the electrical equipment. For example, the filament of a bulb gets heated up due to electric current and therefore glows.
- **Mechanical effect:** electric current can lead to generation of mechanical energy in appliances. For example, fans and motors work due to this effect.
- **Magnetic effect:** electric current can give rise to the magnetic field of a substance.
- **Chemical effect:** electric current can lead to the production of chemical energy or chemical reactions.

## Chemical effects of electric current

We know that when an electric current passes through solution it ionizes and breaks down into ions. This is because of **chemical reactions** that take place when an electric current passes through a solution. Depending on the nature of the solution and the electrodes used, the following effects can be observed in the solution:

1. metallic deposits on the electrodes
2. change in the colour of the solution
3. a release of gas or production of bubbles in the solution

## Applications of chemical effects of electric current

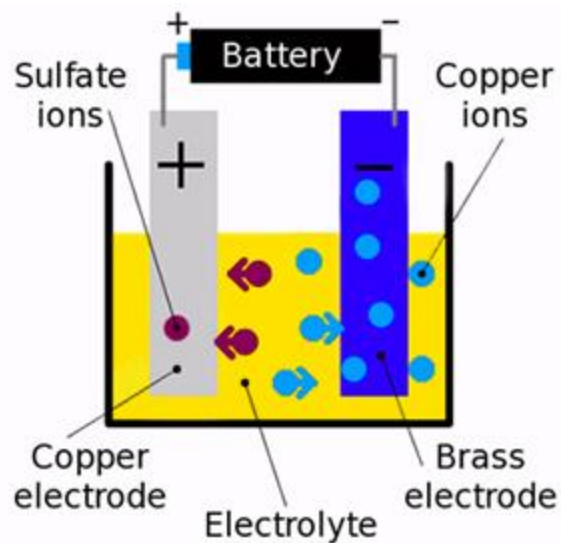
### Electroplating

- Electroplating is a process in which layer of metal is deposited on another material with the help of electricity.
- Electroplating is used in many industries for depositing a layer of metal with desired characteristics on another metal.
- Different metals used for electroplating are Nickel, Copper, Gold Silver, Tin, Brass, Zinc, Chromium and Platinum.

## Process of electroplating

- In order to conduct electroplating right electrodes and electrolytes must be chosen so that metal can deposit over a material.
- For instance, if we want to deposit copper on a material we need an electrolyte that contains copper in it. Similarly, if we need gold on a material we need an electrolyte that contains gold in it.
- Also, we should make sure that the electrode that we are choosing is completely clean.

- The electrodes used are made up of different materials. One of the electrodes is of the same metal of which the electrolyte solution is. The second electrode needs to be the material on which we want to coat another metal.
- For instance, in case we want to plate copper upon brass, one electrode should be of Copper and the other electrode should be of Brass and the electrolyte solution should be any salt which contains copper in it, for example, copper sulphate solution. Consider the diagram given below that describes the process of electroplating of copper.



**Figure 6 Electroplating of copper on brass**

- Out of these two electrodes the copper electrode acts as the anode (positive electrode) and brass electrode acts as the cathode (negative electrode).
- When electricity is passed through the solution, the copper sulphate breaks down into its ions.
- The copper ions (they have a positive charge) get attracted by the brass electrode while the sulphur ions being negatively charged move towards the copper electrode.
- As a result, copper starts depositing on the brass electrode.
- The process of electroplating takes some time to complete.
- The amount of time that it will take depends upon the strength of the current that is being passed through the circuit and also upon the concentration of the electrolyte.
- As these two are increased the speed of the electroplating process also increases.

## Applications of electroplating



Figure 7 Electroplated Objects

- Medical equipment is made up of nickel which is harmful to the human body hence to avoid it from coming in contact with our body a coating of platinum or gold is applied on the surface of nickel.
- Many kitchen equipments, bath taps, parts of cars etc. are covered with chromium coating. Chromium is an expensive metal hence the objects are created with the cheaper metal and chromium coating is provided. Thus, to bring a shining over the objects and prevent them from corrosion chromium coating is used.
- Jewellery makers often make ornaments of less expensive metals and provide a coating of gold or silver upon them.
- The tin cans that are used to store food are actually made up of iron and have a coating of tin on them. Iron can easily react with food and spoil it, however, tin prevents the food from getting reacted with iron and therefore helps in preventing it from getting spoiled easily.
- Bridges and various parts of automobiles are made up of iron because it provides strength. However in order to prevent iron from getting rusted a coating of zinc is provided over it. This method is also called galvanization of iron.

## Other applications of Chemical Effect of Electric Current

### 1. Extracting metals from their ores

Pure metals are extracted from metal ores with the process of electrolysis. Electricity is passed through the metal ores and they get broken down into an ionic lattice and thus the metal is obtained separately. For example, metals like aluminium, magnesium, potassium, sodium and calcium are obtained from their ores in this way.

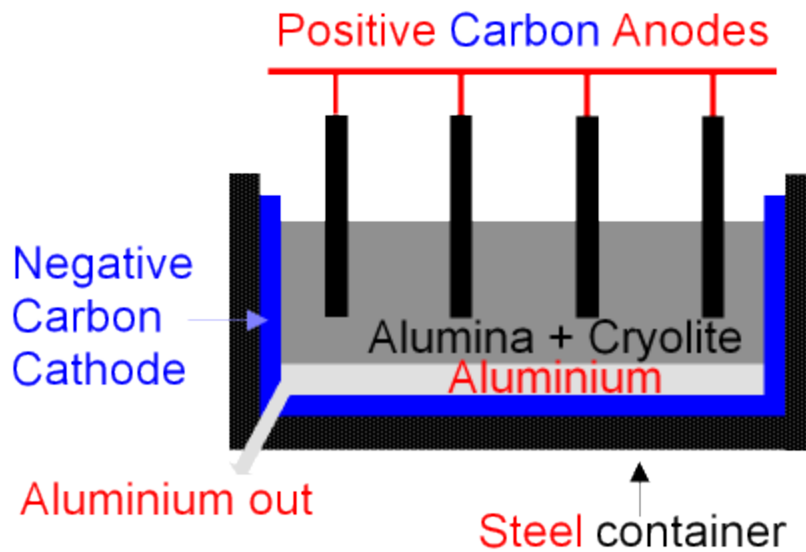


Figure 8 Extraction of Aluminium

## 2. Purification of metals

The method of electrolysis is also used to purify a metal by separating it from the impurities. The impure metal is used as an anode which first dissolves in the electrolyte solution and then deposits on the cathode in the pure form. The impurities of the metal remain in the electrolyte solution only. Metals like aluminium, zinc and copper are purified in this way.

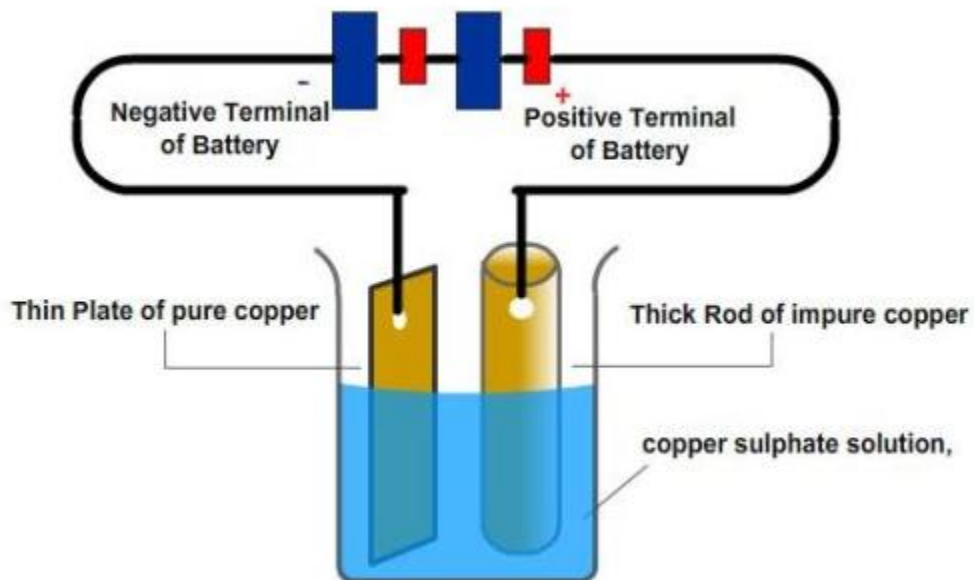


Figure 9 Purification of Copper using Electroplating

## 3. Production of compounds

The electrolysis method is used for the production of some compounds. For example, sodium hydrochlorite



## 4. Decomposition of compounds

The electrolysis method is also used to decompose a compound into its constituents. For example, water can be decomposed using the process of electrolysis to obtain hydrogen and oxygen.

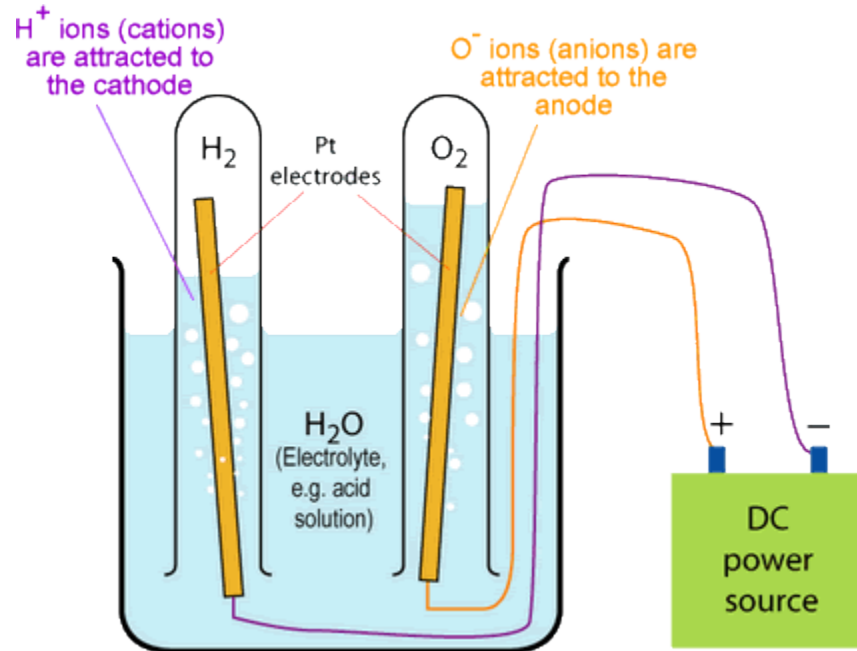


Figure 10 Decomposing water to separate hydrogen and oxygen