

# Centrifugation Notes CBSE

Centrifugation is a technique used to separate components of a mixture based on their size, shape, and density. It works by spinning the mixture at high speed in a machine called a centrifuge, which creates a force called **centrifugal force**. This force pushes denser components outward, away from the centre of the centrifuge, while less dense components are pushed inward.

## Key points:

- **What it does:** Separates components in a mixture.
- **How it works:** Uses centrifugal force created by spinning the mixture at high speed.
- **What separates:** Based on size, shape, and density.
- **Used in:** Many fields like biology, chemistry, medicine, and industry.

Learn about, the churning process, centrifugation process, types of centrifugation, and others in detail in this **Centrifugation Notes**.

## Table of Content

- [What is Centrifugation?](#)
- [Centrifugation Diagram](#)
- [Factors Affecting Centrifugation](#)
- [Principle of Centrifugation](#)
- [Centrifugation Types](#)
- [Application of Centrifugation](#)

## Churning

Churning is a special process that defines the process of separating butter from cream. Churning is performed manually in older days, using the traditional churner as shown in the image given below, where we take a pot full of milk cream and it fitted with a plunger, now the plunger is rotated to create agitation.

As we can see the process of manual churning is not very efficient it consumes a lot of time and labor. Thus, for processing, larger quantities this method is not very efficient. So, for processing larger quantities, the process of centrifugation is used.

In the process of churning, the plunger is rotated and the container that contains the mixture remains constant, while, in the process of centrifuge, the container containing the mixture rotates itself.

## What is Centrifugation?

**Centrifugation** is a mechanical technique for separation that involves the usage of centrifugal force to separate particles contained in a solution. The particles are segregated depending on their size, shape, density, and rotor speed. The suspended particles in a mixture are rotated at a high speed in a machine, called the centrifuge in order to segregate the particles from the liquid. The mixture is separated through spinning. Centrifugation is used for milk separation, cheese production, pulp control in juices, edible oil production, essential oil retrieval, and the production of starch and yeast.

## Centrifugation Definition

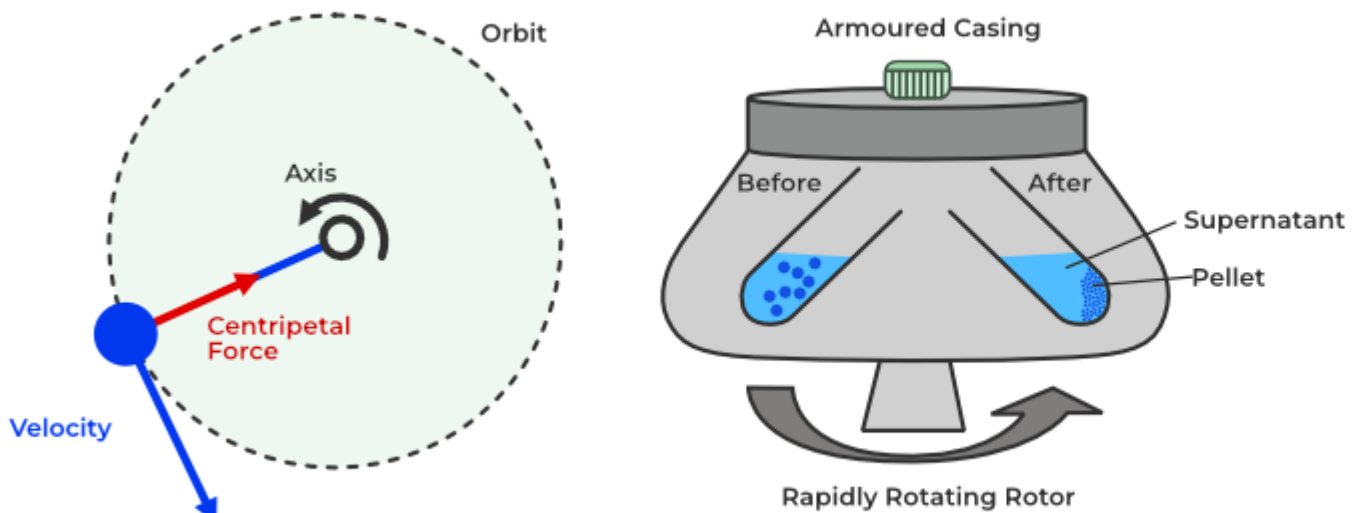
Centrifugation is a process for the separation of phases (liquid-liquid or solid-liquid) that differ from each other in their density, using centrifugal acceleration.

The many applications of mechanical centrifugation in the food industry include milk separation, cheese production, pulp control in juices, edible oil production, essential oil recovery, and the production of starch and yeast. As centrifugation is decantation in a field of centrifugal forces, its comparison with gravitational settling is instructive.

Centrifugation is a method of separating molecules having different densities by spinning them in solution around an axis (in a centrifuge rotor) at high speed. It is one of the most useful and frequently employed techniques in the molecular biology laboratory. This method is preferred as a separation technique where the suspended particles in the liquid are significantly small to be retained by the filter paper. Therefore, the filtration technique cannot be used to separate them. The larger size and density of the particles help in the easier filtration of these particles.

## Centrifugation Diagram

Centrifugation is shown in the diagram added below,



### Read More

- [What is a Solution?](#)
- [What is a Mixture?](#)

## Factors Affecting Centrifugation

The following factors affect the rate or the process of Centrifugation:

- The density of both the solvent and solution,
- Distance of the suspended particles displaced from their original position,
- The temperature of the medium,
- The viscosity of the medium
- Speed of rotation of the centrifuge

## Principle of Centrifugation

Centrifugation Principle is based on the Sedimentation process and can be stated as,

The Principle behind the Centrifugation Process is to use a Centrifugal Field to separate particles suspended in liquid media. These are placed in the centrifuge's rotor either in tubes or bottles.

When sedimentation occurs, the suspended material in the fluids is pulled out by gravity. The suspended substance may consist of powder or clay-like particles. Observe tea leaves in a teacup that are sinking at the bottom. Simple Filtration is used to filter particles larger than 5 micrometres from those smaller than 5 micrometres, which do not sediment by gravity. To separate such particles, the central force is needed.

## Process of Centrifugation

A centrifuge is a machine that uses a rotor to use to separate particles from a solution. The particles in biology are typically cells, subcellular organelles, or big molecules; all of them are referred to as particles in this respect.

There are two different centrifuge techniques: one is preparative, with the objective of separating specific particles, and the other is analytical, with the purpose of determining the physical characteristics of the particles that are settling out. Each particle in the sample experiences a centrifugal force as the rotor of the centrifuge rotates; the force is proportional to the sedimentation rate of the particle.

The sedimentation rate of each particle is also affected by the physical characteristics of the particles and the sample solution's viscosity. The sedimentation rate of a particle is proportional to its size (molecular weight) and to the difference between the particle density and the density of the solution at a fixed centrifugal force and liquid viscosity.

## Centrifugation Types

Centrifugation is of various types, some of the main types of Centrifugation process are:

- Differential Centrifugation
- Density Gradient Centrifugation
- Rate Zonal Centrifugation
- Isopycnic Centrifugation

Now, let's read about them in detail.

### Differential Centrifugation

It is the type of centrifugation that is used the most commonly. At 32 degrees, tissue, such as the liver, is homogenised in a sucrose solution including buffer. The homogenate is then put in a centrifuge and spun at a fixed temperature and centrifugal force. After some time, a pellet-shaped sediment and cell suspension solution form at the bottom of a centrifuge. The upper solution is then poured into a different centrifuge tube and rotated at increasingly higher speeds.

### Density Gradient Centrifugation

The main uses of this type of centrifugation are the purification of membranes, ribosomes, viruses, etc. Lower amounts of sucrose are gently layered on top of greater concentrations in centrifuge tubes to generate a sucrose density gradient. In ultracentrifuges, the target particles are placed on top of the gradient and centrifuged. The particles move through the gradient until they come to a point where their density is equal to that of the sucrose around them. The fraction is taken out and analysed.

### Rate Zonal Centrifugation

The solution has a density gradient during rate zonal centrifugation. Since the sample has a higher density than all of the solution's layers, it is superior. On a density gradient, the sample is applied in a thin zone at the top of the centrifuge tube. The particles will start segmenting through the gradient due to centrifugal force. According to their size, shape, and density, the particles will start dividing into distinct zones.

## Isopycnic Centrifugation

The solution contains a broader range of densities in this type of centrifugation. The range of particle densities in the sample pool is all represented by the gradient of density, which stops each particle with sediment only at the point in the centrifuge tube where the gradient density is equal to the density of the particle. In sedimentation, particles are separated into zones based on their differences in densities, independent of time.

## Centrifugation Sedimentation Coefficient

The sedimentation coefficient (S) is a measure of how quickly a particle settles during centrifugation. It tells us how fast a particle moves under the force of gravity applied during centrifugation. It is represented by the symbol "S" and is measured in seconds. A typical value for sedimentation coefficient is  $1 \times 10^{-13}$  sec.

To find sedimentation coefficient, scientists measure how the concentration of a substance changes over distance as it settles during centrifugation.

The sedimentation coefficient depends on the size, mass, and density of the particle. It is directly related to the particle's buoyant molar mass ( $M_b$ ) and inversely related to its frictional coefficient (f).

In simpler terms, sedimentation coefficient helps us understand how quickly particles of different sizes, masses, and densities settle in a centrifuge.

## Application of Centrifugation

Centrifugation has various examples some of the important examples of centrifugation are

- Clay particles suspended in water as a solvent can be separated using centrifugation.
- Separation of cream from milk.
- Washing machines in order to squeeze out the excess water from the clothes and dry them.
- Laboratories carry out certain types of blood and urine tests.
- Treatment of water is done using centrifugation.

## Commercial Applications of Centrifugation

The commercial application of centrifugation is added below,

- Centrifuges with a batch weight of up to 2,200 kg per charge are used in the sugar industry to separate the sugar crystals from the mother liquor.
- Standalone centrifuges are used for drying (hand-washed) clothes – usually with a water outlet.
- Collection and stabilization of the wine is also achieved using Centrifugation
- Oil industry to separate out the solids from drilling liquids.

## Centrifugation Machine

A centrifugation machine, commonly known as a centrifuge, is a piece of laboratory equipment used for separating substances of different densities in a mixture. It works on the principle of centrifugal force, which is generated by spinning samples at high speeds.

Here's how a centrifuge typically works:

1. **Sample Loading:** The sample to be separated is placed into tubes or containers that fit into the rotor of the centrifuge.
2. **Rotor and Spinning:** The rotor is the part of the centrifuge that holds the sample tubes. When the centrifuge is turned on, the rotor spins rapidly, creating centrifugal force.
3. **Separation Process:** As the rotor spins, the centrifugal force pushes denser components of the sample outward while less dense components move toward the center. This separation occurs because the

denser particles experience greater force, causing them to settle at the bottom of the tube.

4. **Collection:** After centrifugation, the separated components can be carefully collected from the tubes for further analysis or processing.

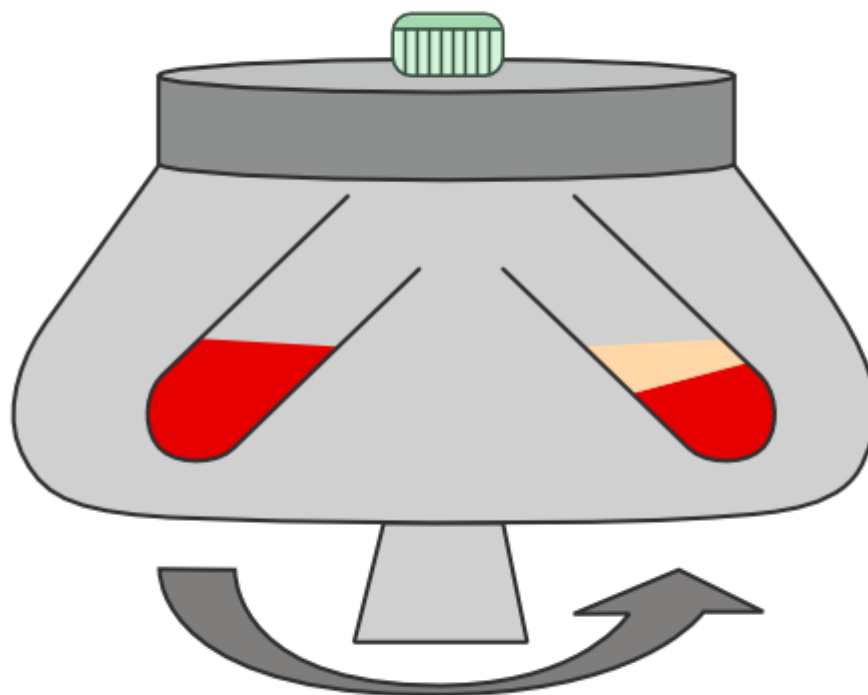
Centrifuges come in various sizes and types depending on their intended use. Some common types include:

- **Microcentrifuges:** Used for small volumes of samples, typically in the milliliter range.
- **Refrigerated Centrifuges:** Equipped with cooling systems to maintain low temperatures during centrifugation, often used for temperature-sensitive samples.
- **Ultracentrifuges:** Capable of reaching very high speeds, used for separating very small particles or molecules, such as proteins and nucleic acids.

## Centrifugation PDF

### Centrifugation of Blood

Centrifugation of blood is done to separate the constituent of the blood. We use centrifugation of blood to separate WBC, RBC and Platelets from the blood. The centrifugation of blood through centrifugation machine is shown in the image added below:



Centrifugation of Blood

### Differentiate between Centrifugation and Filtration

The differences between Centrifugation and Filtration are given in the table given below:

Filtration	Centrifugation
In filtration, the size of the particles to be extracted is slightly smaller.	In Centrifugation, the size of the particles to be extracted is much smaller.
Filtration uses filter media, such as a filter screen or paper.	Centrifugation uses a rotatory machine, called a centrifuge.
Filtration doesn't use centrifugation force	Centrifugation uses centrifugation force

**Also Read,**

- [Separation of Mixtures](#)
- [Fractional Distillation](#)
- [Evaporation](#)

## FAQs on Centrifugation

### 1. Define Centrifugation.

Centrifugation is a process for the separation of phases (liquid-liquid or solid-liquid) that differ from each other in their density, using centrifugal acceleration.

### 2. What is the Principle of Centrifugation?

Principle behind the Centrifugation Process is to use a Centrifugal Field to separate particles suspended in liquid media. These are placed in the centrifuge's rotor either in tubes or bottles.

### 3. What is the use of Principle of Centrifugation in Blood Banks?

Blood is a colloidal solution, as we well aware (neither dissolves nor settles down). A centrifuge machine is helpful in blood banks. A test tube containing blood samples was rotating rapidly within the centrifuge. The blood's components separate as a result of centripetal acceleration, which causes the heavier component to settle down.

### 4. What is Mean by Centrifugal Pump?

A hydraulic device known as a centrifugal pump uses centrifugal force to transform mechanical energy into hydraulic energy. It operates under the tenet that as the pressure head increases, so does tangential velocity.

### 5. What is Centrifuge?

The centrifuge consists of a rotor enclosed in a refrigerated chamber which is rotated by an electric motor. The centrifuge uses centrifugal force in order to differentiate between the different phases of varying densities. A centrifuge is based on the principle of sedimentation, that is the larger density particles settle down at the bottom of the container.

### 6. What is the Use of a Centrifuge?

Centrifuge is a machine that separates two materials with differences in their densities. Centrifuges are used in,

- Laboratories to separate fluids or gases.

- For separation of different constituents of blood, wastewater sludge, various solution, etc.

## **7. What are the Types of Centrifugation?**

In general, there are two types of centrifugal techniques available they are:

- Differential Centrifugation
- Centrifugation of Density Gradients.

Density gradient centrifugation is further classified into:

- Rate-Zonal centrifugation
- Isopycnic centrifugation