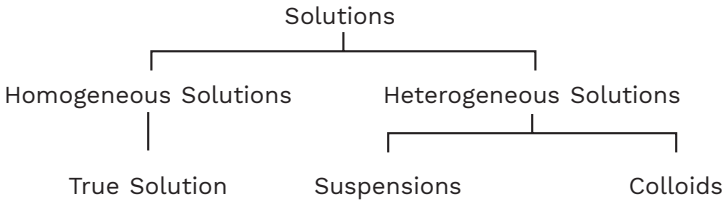
# EXPERIMENT 1
## (THEORY)

## SOLUTION

A solution is a homogeneous mixture of two or more substances. A solution can be of solids, liquids or gas.

Components of a solution are:



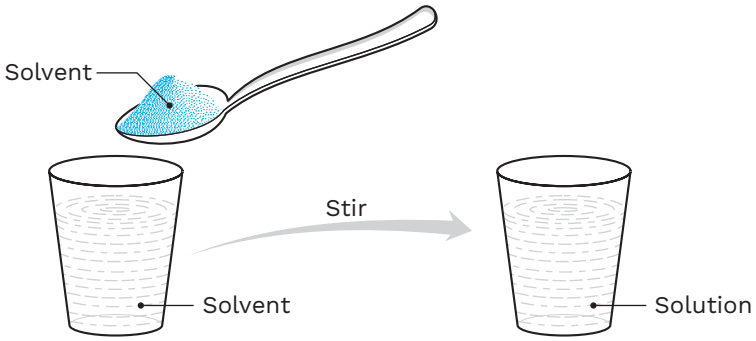

### Solvent

The component of a solution which is present in large proportion is called solvent.

### Solute

The component of the solution which is present is small proportion is called solute.

**For example:** In the solution of common salt in water, the common salt is solute and water is solvent.




## CONCENTRATION OF A SOLUTION

It is the amount of solute present in a given amount of solution.

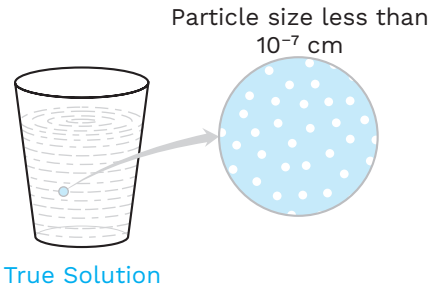
$$\text{Concentration of a solution} = \frac{\text{Amount of solute}}{\text{Amount of solution}}$$

## PRINCIPLE APPLIED IN THE EXPERIMENT

### True solutions

It is a homogenous solution containing a mixture of two or more substances dissolved in a solvent. The solute particles are very small. For example salt dissolves in water to form salt solution which is a true solution.

### Properties of True solution

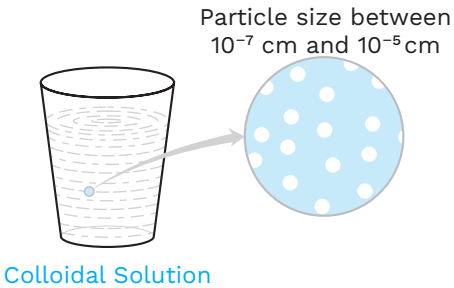



- It is a homogeneous mixture of solute and solvent.
- The solute particles are very small, of the order of about $10^{-7}$cm.
- They do not scatter light, i.e. they do not show Tyndall effect.
- The composition and properties of a true solution are the same throughout and the solution is clear and transparent.
- In a true solution, the particles of solute do not settle down, provided temperature is constant.
- From a true solution, the solute can easily be recovered by evaporation or crystallization.

## SUSPENSION

It is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye. For example flour or chalk particles in water, in which particles of flour or chalk are suspended in water.

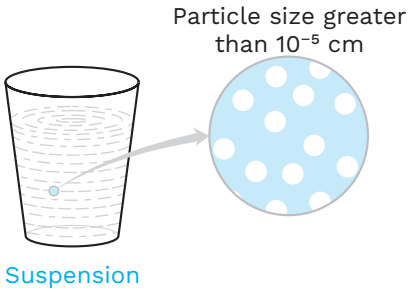
### Properties of Suspension




- It is a heterogeneous mixture.
- The size of particles is more than $10^{-5}$ cm and can be seen with naked eyes.
- The particles of suspensions settle down, when the suspension is kept undisturbed, due to the effect of gravity.
- The particles of suspension, in its suspended form, scatter a beam of light i.e. shows Tyndall effect.
- More scattering takes place in suspensions, because of bigger size of particles.
- The particles of suspension can be separated from solvent by the process of filtration.
- It is opaque, unstable and settles down after some time.

## COLLOIDAL SOLUTIONS

It is a heterogeneous mixture consisting of two or more substance in which the solute particles neither dissolve nor settle down in a solvent. For example milk mixed with water.




### Properties of Colloidal Solution

- It is a heterogeneous mixture that appears to be homogeneous.
- The size of colloidal particles is in between $10^{-7}$ cm and $10^{-4}$ cm.
- The particles of a colloidal solution do not settle down when left undisturbed.
- The particles of a colloidal solution can easily pass through filter paper. They can be separated by centrifugation, electrophoresis etc.
- The particles of a colloidal solution scatter light, i.e., when strong beam of light is passed through the colloidal solution, the path of beam becomes visible.
- Colloidal solutions are not transparent, but translucent in nature.
- The particles of a colloidal solution are electrically charged.

# EXPERIMENT 1
## (PRACTICAL)

**A.** Preparation of a true solution of common salt, sugar and alum

**B.** Preparation of a suspension of soil, chalk powder and fine sand in water

**C.** Preparation of a colloidal solution of starch in water and egg albumin/milk in water and

**D.** Distinction between these on the basis of :

i. Transparency

ii. Filtration criterion

iii. Stability

## TOPIC

Solution, Colloid and Suspension

## MATERIALS REQUIRED

Beakers (250 ml), a test tube stand, a tripod stand, an iron stand, a glass rod, Bunsen burner, wire gauze, three funnels, 3 filter papers, and a china dish.

## CHEMICALS REQUIRED

Common salt, sugar crystals, alum powder, soil, chalk powder, fine sand, raw egg, starch, distilled water and dil. $H_2SO_4$ or dil. HCl.

### Precautions

- Always use distilled water to make solutions.
- The solid solute should be powdered so that it dissolves faster.
- Solute should be added into water carefully.
- Stirring should be done in such a way that the glass rod does not strike with the beaker (or test tube).

- The glass rod must be cleaned thoroughly before using it to stir the other solution.
- Wash your hands properly after performing the experiment.
- Dry starch should never be added to warm water to prevent lump formation.
- All the solutions should be stirred well.

## PROCEDURE

### A. Preparation of a true solution of common salt, sugar and alum in water

#### 1. First prepare true solution of common salt

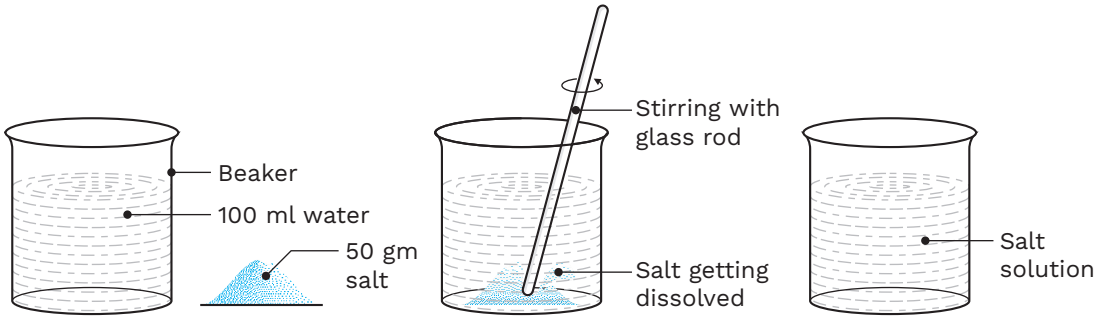
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of common salt in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker so that salt dissolves completely.

**Step 5 :** A true solution of common salt in water is ready.




**Expected Observation**

Student will observe that common salt dissolves completely and the solution obtained will be transparent. Also the particles will not settle down on keeping the solution undisturbed for some time.

**Student's Observation**

#### 2. True solution of sugar and water

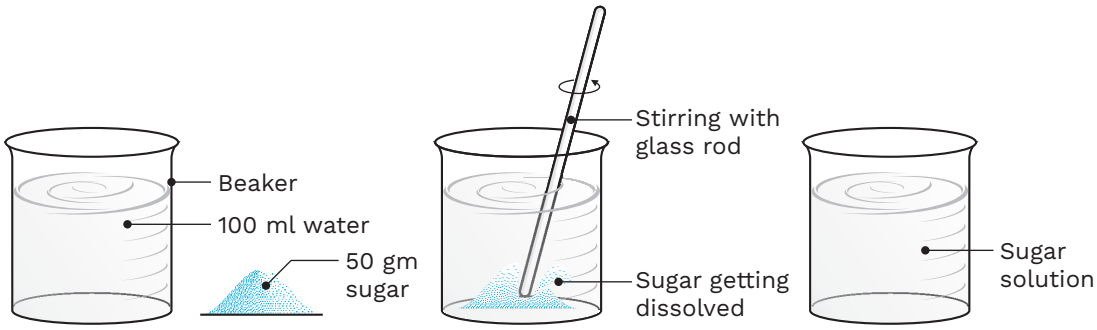
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of sugar in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker so that sugar dissolves completely.

**Step 5 :** A true solution of sugar in water is ready.




### Expected Observations

Student will observe that sugar dissolves completely and the solution obtained will be transparent. Also the particles will not settle down on keeping the solution undisturbed for some time.

### Student's Observations

## 3. True solution of alum and water

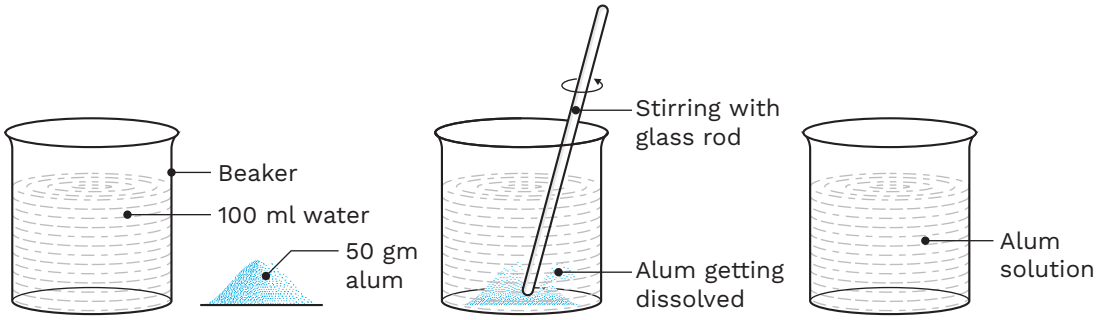
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of alum in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker so that alum dissolves completely.

**Step 5 :** A true solution of alum in water is ready.



**Expected Observations**

Student will observe that alum dissolves completely in water and the solution obtained will be transparent and particles do not settle down on keeping the solution undisturbed for some time.

**Student's Observations**

## B. Preparation of a suspension of soil, chalk powder and fine sand in water

### 1. Suspension of sand in water

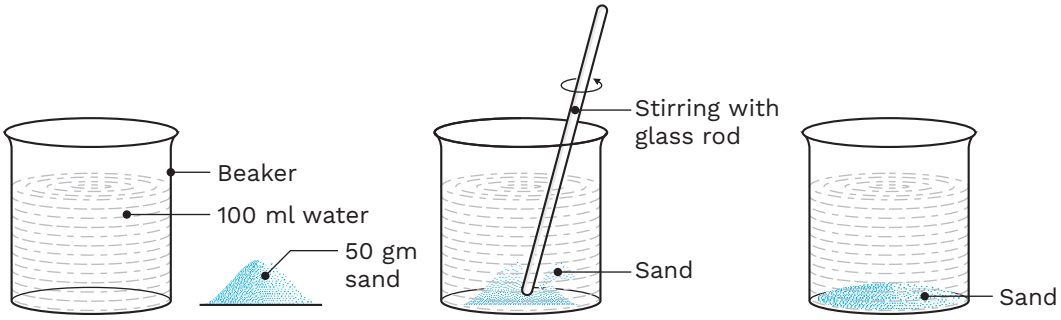
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of fine sand in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker

**Step 5 :** Allow it to stand for 5-6 minutes.




**Expected Observations**

Student will observe that particles of fine sand will not dissolve in water. And particles will also be clearly visible.

**Student's Observations**

### 2. Suspension of chalk powder in water

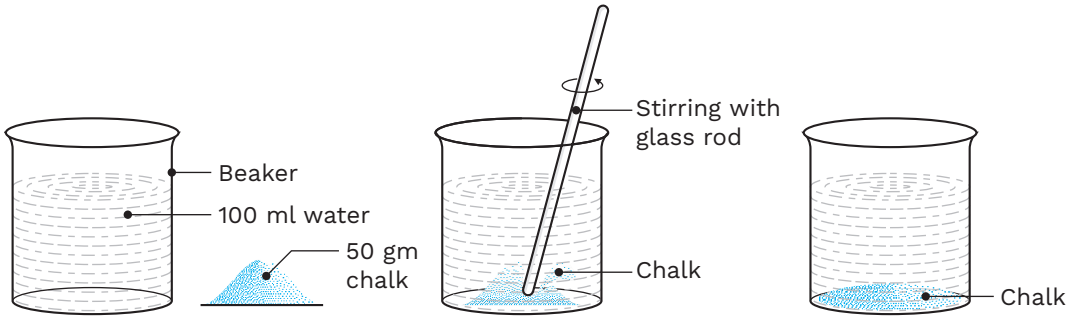
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of chalk powder in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker

**Step 5 :** Allow it to stand for 5-6 minutes.




### Expected Observations

Student will observe that particles of chalk powder will not dissolve in water. And particles will also be clearly visible.

### Student's Observations

## 3. Suspension of soil in water

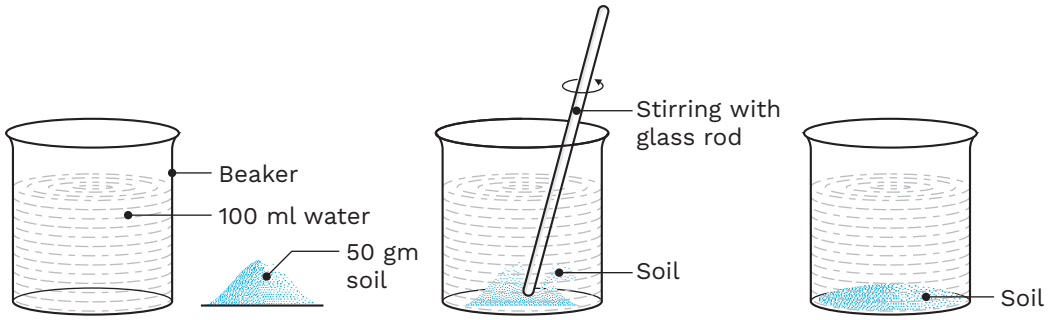
**Step 1 :** Take a clean and dry beaker.

**Step 2 :** Take about 100 ml of distilled water in the beaker.

**Step 3 :** With the help of a spoon add about 50 grams of garden soil in the water taken in the beaker.

**Step 4 :** Take a clean glass rod and stir the water in the beaker

**Step 5 :** Allow it to stand for 5-6 minutes.




### Expected Observations

Student will observe that particles of soil will not dissolve in water. And particles will also be clearly visible.

### Student's Observations

## C. Preparation of a colloidal solution of starch and egg albumin in water:

### 1. Colloidal solution of starch in water:

**Step 1 :** Take about 1 gram of starch in a test tube and pour 10 ml of distilled water in it.

**Step 2 :** Stir the mixture to make a paste like mass.

**Step 3 :** Now take about 100 ml of distilled water in the beaker and heat the water using Bunsen burner.

**Step 4 :** Transfer the paste of starch and water with continuous stirring in the boiling water so that no lump formation takes place.

**Step 5 :** Heat and stir the contents thoroughly so that the paste of starch disappears.

**Step 6 :** Allow it to stand for 5-6 minutes.

**Expected Observations**

Students will observe that starch will completely dissolve in water and the solution obtained will be translucent. Also no sediments will settle down at the bottom of the beaker.

**Student's Observations**

### 2. Colloidal solution of egg albumin in water

**Step 1 :** Take an egg and break it carefully so that we can separate the egg yolk from egg albumin (which is the white part).

**Step 2 :** Add a very small quantity of egg albumin to warm water.

**Step 3 :** With the help of a spoon add more albumins and stir the contents thoroughly.

**Step 4 :** Then add 90 ml of distilled water with continuous stirring and few drops of dil. Acid (dil. HCl or dil. $H_2SO_4$). The clear solution of albumin and water will become turbid

**Step 5 :** Allow it to stand for 5-6 minutes.

**Expected Observations**

Student will observe that egg albumin will completely dissolve in water. The solution obtained will be translucent and no sediments will settle down at the bottom of the beaker.

**Student's Observations**

## D. Distinction between the above formed solutions on the basis of

### 1. Transparency

**Step 1 :** Take three test tubes and label them as A, B and C and place them on a test tube stand.

**Step 2 :** Mark a sign of cross(×) in the lower half of all the tubes.

**Step 3 :** Fill test tube A with true solution of common salt, test tube B with suspension of chalk powder and test tube C with colloidal solution of egg albumin in water.

**Step 4 :** Look at the tick mark through the contents of the three test tubes from the other side.

**Step 5 :** Check for the transparency of tick mark.

**Expected Observations**

- Student will observe that the mark (×) will be clearly visible when seen through the test tube A.
- Student will observe that the mark (×) will not be visible when seen through the test tube B.
- Student will observe that the mark (×) will be faintly visible when seen through the test tube C.

**Student's Observations**

### 2. Filtration criterion

**Step 1 :** Take three test tubes and label them as D, E and F.

**Step 2 :** Place them on a test tube stand and also place a funnel over the test tubes D, E and F.

**Step 2 :** Fix the filter paper in the funnels.

**Step 3 :** Filter the contents of test tube A, B and C separately through the filter paper and collect the filtrate in three clean test tubes labeled as D, E and F respectively.

**Step 4 :** Observe the filtrate and the residue left on the filter paper.

**Expected Observations**

- In case of test tube A, student will obtain a clear filtrate in test tube D and no residue will be left on the filter paper.
- In case of test tube B, student will obtain a clear filtrate in test tube E and some residue will be on the filter paper.
- In case of test tube C, student will obtain a translucent filtrate in test tube F and no residue will be left on the filter paper.

**Student's Observations**

### 3. Stability

**Step 1 :** Take a colloid, a suspension and true solution in three different test tubes A, B and C placed on a test tube stand.

**Step 2 :** Shake all the test tubes and keep them on a test tube stand undisturbed for about 5 minutes.

**Step 3 :** Record your observations.

**Expected Observations**

- In case of test tube A, student will observe that the contents show no change.
- In case of test tube B, student will observe that bigger particles tend to settle down at the bottom of test tube B.
- In case of test tube C, student will observe that the contents remain unchanged and no solid particles settle down.

**Student's Observations**

## INFERENCE TABLE

| S. No. | Property | True Solution | Suspension | Colloidal Solution |
|---|---|---|---|---|
| 1. | Transparency | The common salt solution is transparent and so it is a true solution. | The suspension of chalk powder is opaque. So it is a suspension | The solution of egg albumin is translucent. So it is a colloidal solution. |
| 2. | Filtration | Common salt cannot be separated from its solution in water by filtration. So, sample A is a true solution. | Chalk powder can be separated from its suspension in water by filtration. So, sample B is a true solution. | Egg albumin cannot be separated from its colloidal solution in water by filtration. So, sample C is a colloidal solution. |
| 3. | Stability | True solution of common salt in water is stable | The suspension of chalk powder in water is unstable. | The colloidal solution of egg albumin in water is stable. |

| S. No. | Property | True Solution | Suspension | Colloidal Solution |
|---|---|---|---|---|
| 4. | Visibility | Solute particles of true solution are invisible to naked eye. | Solute particles of suspension are visible to naked eye. | Solute particles of colloidal solution are invisible to naked eye. |
| 5. | Nature | Homogeneous | Heterogeneous | Appears homogeneous but is heterogeneous. |

## RESULT

- True solutions are homogeneous, transparent, and stable and its components cannot be separated by filtration.
- Suspensions are heterogeneous, opaque, and unstable and its components can be separated by filtration.
- Colloidal solutions are heterogeneous, translucent, and stable and its components cannot be separated by filtration.

## VIVA-VOCE

**1.** Give one example of liquid solution?

**A.** Lemonade + water

**2.** Give one example of gaseous solution?

**A.** Air

**3.** Give one example of solid solution?

**A.** Alloy : Brass – 30 % Zinc and 70 % Copper

**4.** What is the size of particles in true solution?

**A.** The size is less than 1 nm ($10^{-9}$ m) in diameter.

**5.** Are colloids homogeneous or heterogeneous?

**A.** Colloids seem to be homogeneous, but they are actually heterogeneous.

**6.** What will you name the heterogeneous solution whose particle size is between $10^{-7}$ cm to $10^{-4}$ cm?

**A.** Colloidal solution

**7.** Give an example of a solution in which gas is solute and liquid is solvent.

**A.** Aerated drinks.

**8.** How can fat and water in milk be separated?

**A.** By centrifugation

**9.** What kind of solution is milk?

**A.** Milk is a colloid.

**10.** Shaving cream produces foam. What kind of colloid is shaving cream?

**A.** Shaving cream which produces foam is a colloid in which gas is dispersed in a liquid.

**11.** What kind of solution is drinking soda?

**A.** Drinking soda is produced by passing $CO_2$ gas into water. So, it is a gas in liquid solution.

**12.** Give some examples of Tyndall effect observed in your surroundings?

**A.** a. When sunlight passes through the canopy of a dense forest.

b. When a fine beam of light enters a room through a small hole.

## PRACTICAL BASED QUESTIONS

**1.** What does a pure substance mean?

**A.** A pure substance is one, which contains only one type of atoms or molecules in a specific arrangement in any part of the sample taken. Example: water, diamond.

**2.** What type of mixture is separated by the technique of crystallization?

**A.** Crystallization is a technique of separation of solid from a liquid solution. It relates to precipitation but here, the precipitate obtained is in crystal form and has a very high purity. This technique is thus used in the purification of impure substances. Example: Salt from sea water after the evaporation.

**3.** Which of the following will show Tyndall effect—

a. Salt solution

b. Milk

c. Copper sulphate solution

d. Starch solution

**A.** Milk and starch solution are colloids and hence will show Tyndall effect.

Copper sulphate solution and salt solution will not show Tyndall effect.

**4.** Where do the solute particles go when added to a solvent to prepare a true solution?

**A.** Solute particles occupy the empty spaces in between the solvent molecules when they are added to the solvent.

**5.** How can a true solution be distinguished from a colloidal solution?

**A.** A true solution can be distinguished from a colloidal solution by experimenting Tyndall effect. A true solution does not scatter a beam of light passing through it but a colloidal solution scatters a beam of light passing through it.

**6.** Name the process by which the various gases of the air are separated?

**A.** Fractional distillation.

**7.** Out of a colloid, solution and suspension:

a. Which one has the smallest particles?

b. Which one has the largest particles?

**A.** a. Solution has the smallest particles.

b. Suspension has the largest particles.

**8.** Siddharth dissolved a mixture into water and then filtered it. Solid X was left behind as residue in the filter paper and solid V was obtained by evaporating the filtrate to dryness. What could X and Y be?

**A.** X will be Calcium carbonate and Y will be sodium chloride as Calcium carbonate is insoluble in water hence; it is left behind in the filter paper. Sodium chloride is soluble in water and is obtained by evaporation of solution.

**9.** What can be observed when sunlight is passed through a colloidal solution?

**A.** Tyndall effect can be observed when sunlight is passed through a colloidal solution.

**10.** What are the materials which contain at least two pure substances and show the properties of their constituents called?

**A.** A mixture is formed by the physical mixing of two or more pure substances (elements or compounds), in variable proportions and the constituents retain their properties even after the mixture is formed.

**11.** What is the process involved in making candy?

**A.** Crystallization is the process involved in the preparation of candy. The sugar and ice crystals formed by the slow cooling of sugar solution gets collected around the sticks, and results in the formation of candy.

**12.** Give one example of a pair of colloidal solution which have dispersed phase as liquid and dispersing medium as gas?

**A.** Fog and mist are colloidal solutions of aerosol type with dispersed phase as liquid and dispersing medium as gas.

**13.** Smoke and fog both are aerosols. In what way are they different?

**A.** In both smoke and fog, dispersion medium is the same i.e., gas but they differ in dispersed phase. In smoke, the dispersed phase is solid while in fog the dispersed phase is liquid.

**14.** Four different mixtures in water are prepared using charcoal powder, chalk powder, slaked lime and detergent powder. Which of these

a. Would not leave residue on filter paper after filtration?

b. Would show Tyndall effect?

c. Would leave residue on filter paper after filtration?

d. Would give transparent /clear solution?

**A.** a. Detergent solution and slaked lime solution, (called lime water) will not leave any residue on filter paper after filtration.

b. Detergent solution will show Tyndall effect.

c. Charcoal power and chalk powder will leave residue on filter paper.

d. Slaked lime will give transparent/ clear solution.

**15.** Give reasons

a. Path of beam of light is not visible through a solution.

b. Particles of suspension can be seen with a naked eye.

**A.** a. Path of beam of light is not visible through a true solution because particles of a true solution do not scatter light while colloidal particles scatter light.

b. Size particles of suspension is greater than 100 nm. So, they can be seen with a naked eye.