Is matter around us pure?

Pure substance

Chemically pure substance is a kind of matter that cannot be separated into other kinds of matter by any physical process. It has the same colour, taste, texture and composition at a given temperature and pressure.

Meaning of pure substance different for a common man than to a chemist

For a common man, pure substance means that it is not adulterated.

For example, for a common man, pure milk means the liquid material that is given by cow or buffalo and it is not mixed with water or other materials to thicken it.

But for a chemist, any milk is not a pure substance. Milk is a mixture of water, fats and proteins.

Purity of a given substance

A pure substance always has the same colour, taste or texture at a given temperature and pressure. Also it has a fixed melting point or boiling point at constant pressure. For example, pure water boils at 373K at 1 atmospheric pressure. But water containing some invisible dissolved substance boils at a temperature above 373K.

Mixture

If two or more substances (elements, compounds or both) mixed together in any proportion, do not undergo any chemical change, but retain their characteristics, the resulting mass is called mixture.

Kinds of Mixtures

Heterogeneous Mixture

A mixture in which various constituents are not mixed uniformly is called heterogeneous mixture.

Examples: A mixture of sand, salt and sulphur is a heterogeneous mixture. Similarly, a handful of soil is a heterogeneous mixture.

Homogeneous mixture

A mixture in which different constituents are mixed uniformly is called homogeneous mixture.

Examples: Brass is an alloy of copper and zinc and is a homogeneousmixture. Similarly, all solutions are homogeneous mixtures.

Characteristics of a Mixture

1. Variable composition: The constituents of a mixture are present in any ratio. Example: A mixture of sand and salt can be in a ratio of 1:2 or 5:6, etc, by weight.
2. Physical change: The mixture is a result of physical change. The constituents of a mixture do not bind each other by chemical bonds. Example: In air the main constituents, i.e., oxygen, nitrogen and carbon dioxide, do not bind each other with chemical bonds.
3. No specific properties: The properties of a mixture are the average of the properties of its constituents.
   Example: The properties of air are midway between properties of nitrogen and oxygen.
4. Homogeneity: Most of the mixtures are heterogeneous, i.e., their constituents are not
   spread evenly throughout. However, some mixtures are homogeneous.
   Example: In the mixture of iron and sulphur, at some places iron is more and at some places sulphur is more.
5. Separation: Generally, the constituents of mixture can be separated by employing
   suitable physical means. Example: Iron can be separated from the mixture of iron and sulphur with the help of a magnet.
6. Energy changes: No energy is released or absorbed during the formation of a mixture. Example: On mixing iron and sulphur, heat energy is neither absorbed nor evolved.

True solution

A solution, in which the particles of the solute are broken down to such a fine state that every portion of the solution has the same properties, is called a true solution. A true solution is a homogeneous mixture of two or more substances. In a true solution, the particles of the solute are broken down to a diameter of the order of 10-8 cm or less. e.g., sugar dissolved in water, iodine in ethyl alcohol (tincture).

Characteristics of True Solution

- A true solution is always clear and transparent, i.e., light can easily pass through it without scattering. This path of light is not visible in a solution.
- The particles of solute break down to almost molecular size and their diameter is of the order of 1 nm (10^{-9} metre) or less.

- A true solution can completely pass through filter paper as particle size of solute is far smaller than the size of pores of filter paper. Thus, the particles of the solute cannot be separated by filtration.
- A true solution is homogeneous in nature.
- In a true solution, the particles of solute do not settle down, provided temperature is constant. Thus, the true solution is stable in nature.
- From a true solution, the solute can easily be recovered by evaporation or crystalliasation.

Solute

The substance(s) present in smaller proportion in a solution is called solute.

Solven

The substance present in larger proportion in a solution is called solvent. If a homogeneous mixture or a solution is formed by dissolving 2 g salt in 100 g water, then salt is the solute and wateris the solvent.

Solubility

The maximum a mount of the solid that can be dissolved in a given amount of the solvent (water) is termed its solubility at that temperature.

Differentiate between a saturated solution and an unsaturated solution

Saturated solution. A solution in which no more of the solid (solute) can be dissolved at a given temperature is called a saturated solution.

Unsaturated solution

A solution in which more of the solid can be dissolved at the given temperature is called an unsaturated- solution.

Test whether a given solution is saturated or not.

If to a given solution, more salt is added and it dissolves, then it is unsaturated. If the salt added settles down; it is saturated.

For example,
brass is a mixture of approximately 30% zinc and 70% copper.

Concentration of a solution

The concentration of a solution is the amount of solute present in a given amount (mass or volume) of solution, or the amount of solute dissolved in a given mass or volume of a solvent.

Concentration of solution = Amount of solute / Amount of solution Or Amount of solute/Amount of solvent.

Expressing the Concentration of a Solution:

The concentration of a solution is expressed as the amount of the solute present in a given amount of the solvent or solution. It is normally expressed as mass percent or as volume percent.

Mass Percent

Mass percent of a solution may be defined as: **the number of parts by mass of one component (solute or solvent) per 100 parts by mass of the solution.**

$$\text{Mass percent of A} = \frac{W_A}{W_A + W_B} \times 100$$

$$\text{Mass percent of B} = \frac{W_B}{W_A + W_B} \times 100$$

Volume Percent

Volume percent of a solution may be defined as: the number of parts by volume of one component (solute or solvent) per 100 parts by volume of the solution.

$$\text{Mathematically, Volume percent of A} = \frac{V_A}{V_A + V_B} \times 100$$

$$\text{Volume percent of B} = \frac{V_B}{V_A + V_B} \times 100$$

Example:

A solution contains 40g of common salt in 320 g of water. Calculate the concentration in terms of mass by mass percentage of the solution.

Ans. Mass of solute (salt) = 40g, Mass of solvent (water) = 320g

We know, Mass of solution = Mass of solute + Mass of solvent = 40 g +320 g = 360 g

Mass percentage of solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{40}{360} \times 100 = \mathbf{11{\cdot}1\%}$$

Q. A solution has been prepared by dissolving 5g of urea in 95 g of water. What is mass percent of urea in the solution?

Ans = 5%

Q. Calculate the masses of cane sugar and water required to prepare 250 g of 2i solution of cane sugar.

Ans = mass of cane sugar = 62.5g, mass of water = 187.5g

Q. A solution contains 35 g of common salt in 300 g of water. Calculate the concentrate of the solution.

Ans = Concentration of solution is=10.45%

Q. A solution contains 5 mL of alcohol mixed with 75 mL of water. Calculate its concentration of the solution in terms of volume percent.

Ans = 6.25%

Suspensions

A heterogeneous mixture of insoluble particles of solute, spread throughout a solvent, is called suspension.

The particle size (diameter) in a suspension is more than 10-5 cm. The particles have a tendency to settle down at the base of solvent and can be filtered out, because their size is bigger than the size of the pores of filter paper. Following are some examples of common suspensions:

- Muddy water, in which particles of sand and clay are suspended in water.
- Slaked lime suspension used for white washing has particles of slaked lime suspended in water.
- Paints in which the particles of dyes are suspended in turpentine oil.

Characteristics of Suspensions:

- The size of particles is more than 10-5 cm in diameter and hence can be seen with unaided eye.

- The particles of suspension can be separated from solvent by the process of filtration.
- The particles of suspension settle down, when the suspension is kept undisturbed. The process of settling of suspended particles under the action of gravity is called sedimentation. Thus, we can say that suspensions are unstable.
- A suspension is heterogeneous in nature.
- An excessive amount of scattering takes place in suspensions, because of bigger size of particles. Therefore, path of light is not visible.

Colloidal Solutions or Colloids:

A neither heterogeneous solution in which the particle size is in between 10-7 cm to 10-5 cm, such that the solute particles neither dissolve nor settle down in a solvent is called colloidal solution.

Dispersed phase and dispersing medium:

In a colloidal solution, relatively large suspended particles are called dispersed phase and the solvent in which the colloidal particles are suspended is called continuous phase or dispersing medium.

Characteristics of Colloidal Solutions:

- The size of a colloidal particle is in between 10-7 cm and 10-5 cm.
- The particles of a colloidal solution are visible under powerful microscope.
- The particles of a colloidal solution do not settle down with the passage of time. Therefore, colloidal solutions are quite stable.
- The particles of a colloidal solution cannot be recovered by crystallization or evaporation. However, they can be separated by the process of centrifugation.
- The particles of a colloidal solution can easily pass through filter paper and hence cannot be separated by filtration.
- 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 colloidal solutions are heterogeneous in nature.

Tyndall effect:

When strong beam of light is passed through a true solution taken in a beaker placed in a dark room, the path of light through the solution is dark. But if the light is passed through a colloidal solution under conditions as above, the path of light through the colloidal solution becomes visible.

This is called Tyndall effect. The colloidal particles become illuminated because they scatter the light falling on them in all directions.