9. Solutions

Part-A

1. Question

A true solution is a homogeneous mixture of solute and solvent. Chalk powder in water is a heterogenous mixture. Is it a true solution?

Answer

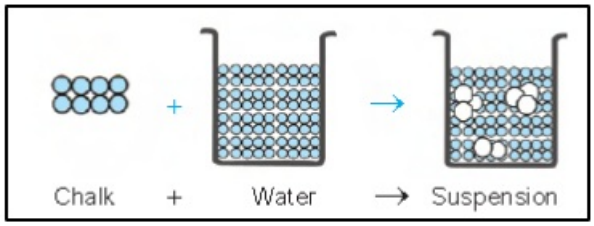
No, chalk powder in water is not a true solution.

A true solution is a homogeneous mixture in which solute particles are uniformly dissolved throughout the solvent but chalk powder in water is insoluble and not uniformly distributed throughout the solvent (water). Moreover, the solid particles of chalk in water are large enough to be seen by naked eyes. These all are the properties of a suspension. Thus we can say that chalk powder in water is a suspension.

(Suspension: it is a heterogenous mixture of small insoluble particles in a solvent which can be clearly seen by eyes.

Homogenous solution: it is a mixture in which composition of solute is uniform throughout the solvent.

Heterogenous solution: it is a mixture in which composition of solute is not uniform throughout the solvent.)



2. Question

A solution that contains water as the solvent is called an aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _____.

(aqueous solution, non- aqueous solution)

Answer

If carbon disulphide (CS_2) is a solvent in a given solution, then the solution is called non-aqueous solution.

ny solution containing water as solvent is known as aqueous solution. This can be understood with example of a salt solution. In a salt solution, salt is the solute and water is the solvent, therefore it is an aqueous solution. But when a solution has any liquid other than water as solvent then it is known as non-aqueous solution. For example a solution of sulphur in carbon disulphide is a non-aqueous solution because here solvent is carbon disulphide and not water.

3. Question

The solubility of common salt in 100g of water is 36g. If 20g of salt is dissolved in it, how much more is required to attain saturation?

Answer

Solubility of any solute (common salt) in a given solvent (water) is defined as the grams of solute required to saturate the 100g of the given solvent at a particular temperature. The term saturation means that no more solute can be dissolved in a given amount of solvent at a particular temperature.

So, from the above information, we can conclude that 36g of common salt is needed to be dissolved in 100g of water to make a saturated solution. So if 20g are already dissolved than we require 16g (36-20=16) more common salt to attain saturation.

4. Question

If two liquids are mutually soluble, they are called _____ liquids. (miscible, immiscible)

Answer

If two liquids are mutually soluble, they are called miscible liquids.

miscible liquids are those liquids which readily mix with each other. Examples of miscible liquids are water and alcohol. If we take water in a test tube and then add alcohol to it then we will observe that they mix together and we cannot see different layers. Immiscible liquids are those liquids which cannot be mixed together. For example, when you add oil to a test tube that contains water then you can see two different layers indicating that they do not mix together.

5. Question

When sunlight passes through the window of a classroom, its path is visible. This is due to _____of light. (reflection, scattering)

Answer

When sunlight passes through the window of a classroom, its path is visible. This is due to scattering of light.

Air around us contains a large number of dust particles which are not visible to us. When the light from the sun passes through the window of a classroom it interacts with these dust particles and gets redirected in different directions. This is called the scattering of light and it is the reason for visible path of the sunlight passing through the window.

6. Question

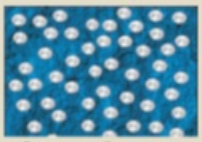
The particles in various forms are visible only under an ultramicro scope. A solution containing such particles is called _____. (true solution, colloidal solution)

Answer

A solution containing such particles which are visible only under an ultramicro scope is called colloidal solution.

The size of colloidal solution particles is intermediate between the size of true solution particles and suspension particles. True solution particles are too small in size to be seen by an ultramicro scope whereas suspension particles are large enough to be seen by naked eyes. So the colloidal solution particles are seen through an ultramicro scope.

The above information is summarized in the given diagram:

Property	True Solution	Colloidal Solution	Suspension
Particle size in Å ($1Å = 10^{-10}m$)	 1Å to 10 Å	 10Å to 2000 Å	 More than 2000 Å
Appearance	Transparent	Translucent	Opaque
Visibility of particles	Not visible even under ultra microscope	Visible under ultra microscope	Visible to the naked eye

7. Question

The number of components in a binary solution are/is _____ (one / two)

Answer

The numbers of components in a binary solution are/is two.

A solution is a homogenous mixture that contains two or more substances. Those solutions which have only two components present in them are called binary solutions. For example, salt solution is a binary solution as it contains only two components i.e. one solute (salt) and solvent (water).

8. Question

The mixture of gases used by deep-sea divers is _____(helium-oxygen, oxygen-nitrogen)

Answer

The mixture of gases used by deep-sea divers is helium-oxygen.

In deep-sea, the pressure is very high which affect the solubility of oxygen in our blood. Under high pressure, the solubility of oxygen can increase to a threatening level in our blood (because of the solubility of gases in liquid increases with the increase in pressure). To prevent such a condition, we need to dilute oxygen with some other inert (non-reactive) gas. So, we use helium which is a non-reactive gas as compared to nitrogen.

9. Question

Soil cannot store more nitrogen than it can hold. Hence soil is said to be in a state of

_____. (saturation, unsaturation)

Answer

Soil cannot store more nitrogen than it can hold. Hence soil is said to be in a state of saturation.

A state of saturation means that no more solute can be dissolved in a given amount of solvent at a particular temperature and state of unsaturation means that more of the solute can be dissolved in a given amount of solvent at a particular temperature.

So, if soil cannot store more nitrogen than it can hold, it means that it has attained the state of saturation.

10. Question

In an endothermic process, solubility increases with _____ in temperature. (increase, decrease)

Answer

In an endothermic process, solubility increases with increase in temperature.

An endothermic process is a process in which we need to give heat to carry out the process i.e. heat is absorbed. For example, the addition of potassium nitrate (KNO_3) to water is an endothermic process. It means that we need to heat the mixture of KNO_3 and water to dissolve KNO_3 in water. This is so because of increasing the temperature the bonds of KNO_3break more easily and thus it gets dissolved easily. In this way, the solubility increases with increase in temperature.

11. Question

Aquatic species are more comfortable in cold water because _____

i). as the temperature decreases, the solubility of dissolved oxygen increases.

ii) as the temperature increases, the solubility of dissolved oxygen increases.

iii) as the temperature increases, the solubility of dissolved oxygen decreases.

Answer

i) as the temperature decreases, the solubility of dissolved oxygen increases.

Dissolution of oxygen in water is an exothermic process which means that heat is released in this process. This is known that for exothermic processes, solubility increases with a decrease in temperature. Also, on heating, the gas molecules gain energy and try to escape out. That’s why when temperature decreases, the solubility of oxygen in water increases due to which the net dissolved oxygen increases which makes aquatic species more comfortable.

Part-B

1. Question

From the table given below, furnish your points of inference.

Substance	Solubility at 25ºC
NaCl	36g
NaBr	95g
NaI	184g

Answer

Solubility of any solute in a given solvent can be defined as grams of solute required to saturate 100g of solvent at a particular temperature. A saturated solution means no more solute can be dissolved in the given amount of solvent at a particular temperature.

So keeping in mind the above definitions, we can furnish following inferences:

•36g NaCl dissolves in 100g water to give a saturated solution at 25^{o}C

•95g NaBr dissolves in 100g of water to give a saturated solution at 25^{o}C

•184g NaI dissolves in 100g of water to give a saturated solution at 25^{o}C

•NaI is more soluble in water than other two at 25^{o}C since maximum grams of it are required to saturate 100g of water.

2. Question

Distinguish between the saturated and unsaturated solution at a temperature of 25^{o}C using the data given below (Note: Solubility of NaCl is 36g)

i) 16g NaCl in 100g water

ii) 36g NaCl in 100g water

Answer

Solubility of NaCl is 36 g means that 36g of NaCl are required to saturate 100g of water at 25^{o}C. With the help of this information and given data, we can distinguish between saturated and unsaturated solution as follows:

Saturated solution	**Unsaturated solution**
It is a solution in which no more solute can be added in a given amount of solvent at a particular temperature (in this case 25ºC)	It is a solution in which more solute can be added in a given amount of solvent at a particular temperature (in this case 25ºC)
Example: 36g NaCl in 100g water	Example: 16g NaCl in 100g water
No more NaCl can be added to it	20g more NaCl can be added to it

3. Question

Differentiate true solution and colloidal solution.

Answer

Property	**True solution**	**Colloidal solution**
Particle size	1Å to 10 Å	10 Å to 2000 Å
Appearance	They look transparent (we can clearly see through them)	They look translucent (we cannot see clearly through them)
Visibility of particles	Not visible under ultramicro scope due to their very small size.	Can be seen under ultramicro scope
Nature	Homogeneous (composition is uniform throughout)	Heterogeneous (composition is not uniform throughout)
Diffusion rate	Diffuses rapidly due to the small size of particles	Diffuses slowly due to the comparatively bigger size of particles
Scattering effect	Does not show scattering effect due to the very small size of particles	It scatters light (redirects light in different directions)

4. Question

You have prepared a saturated solution of sugar at room temperature. Is it possible to dissolve some more grams of sugar to this solution? Justify your answer.

Answer

At room temperature, it is not possible to add some more grams of sugar to its saturated solution. This is because saturated solution means that no more solute can be added to a given amount of a solvent at a

particular temperature (in this case room temperature).

But it is possible to dissolve some more grams of sugars to it by heating the saturated solution of sugar. This is because with increase in temperature, the solubility increases for this process.

5. Question

Find the concentration of the solution in terms of weight percent if 20g of common salt is dissolved in 50g of water.

Answer

Concentration in weight percent can be found as:

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

•Where the weight of solution= weight of the solute + weight of solvent

•The weight of solute (common salt) = 20g

•The weight of solvent (water)= 50g

•Weight of solution= 20g+50g= 70g

$$\text{weight percent} = \frac{20}{70} \times 100$$

$$= 28.57\%$$

6. Question

Valli took some common salt, naphthalene balls, camphor, baking soda and washing soda. She attempted to dissolve these substances either in water or in acetone.

Complete the table with the expected results.

SUBSTANCE	MEDIUM IN WHICH IT IS SOLUBLE	REASON
a. Common salt		
b. Naphthalene balls		
c. Camphor		
d. Baking soda		
e. Washing soda		

Answer

Solubility depends upon the nature of both the solute and solvent. They follow the principle that like dissolves like. It means that a substance having polar nature (ionic compounds like NaCl) can be dissolved in a polar solvent (water) and a non-polar substance (organic compounds) can be dissolved in a non-polar solvent (acetone).

SUBSTANCE	**MEDIUM IN WHICH IT IS SOLUBLE**	**REASON**
a. Common salt	Water	Common salt (NaCl) and water both are polar and a polar compound dissolves in a polar solvent.
b. Naphthalene balls	Acetone	Naphthalene is an organic compound (C_6H_8) and non-polar in nature. Thus, it dissolves in a non- polar solvent acetone.
c. Camphor	Acetone	Camphor ($C_{10}H_{16}O$) is also non-polar like acetone. So, it dissolves in acetone.
d. Baking soda	Water	Baking soda ($NaHCO_3$) is polar in nature like water. So, it dissolves in water.
e. Washing soda	Water	Washing soda (Na_2CO_3) is polar like water. So, it dissolves in water.

7. Question

i) Which gas is dissolved in soft drinks?

ii) What will you do to increase the solubility of this gas?

Answer

i) Carbon dioxide gas (CO_2) is dissolved in soft drinks. When we open a soft drink bottle we observe that lot of bubbles show up. They arise because carbon dioxide trapped inside soft drink bottle starts escaping out.

ii) To increase the solubility of carbon dioxide in soft drinks we can increase the pressure of the gas. The reason for increasing the pressure is that with the increase in the pressure, the solubility of a gas also increases.

8. Question

Beaker A has sugar mixed with water and Beaker B has starch dissolved in water.

i) Which solution will scatter light?

ii) In which beaker does the Brownian movement take place?

iii) Name the type of solution that beaker A and beaker B contain.

iv) Which of the two solutions is homogeneous?

v) Identify the beaker that has particles of size 10Å to 2000Å

Answer

i) Solution in beaker B

Explanation: Sugar mixed with water will form a true solution having very small particle size and particles of such small size would not be able to scatter light. So the solution present in beaker B will scatter light because starch dissolved in water will form a colloidal solution and a colloidal solution scatters the light.

ii) Beaker B

Explanation: Brownian movement is the phenomenon of continuous random motion of colloidal particles and colloidal particles are present in beaker B. Therefore the Brownian movement takes place in beaker B.

iii) Beaker A= True solution Beaker B= Colloidal solution

Explanation: Since sugar gets completely dissolved in water forming a homogenous solution, thus the solution present in beaker A is true solution. But the starch molecules are bigger in size and they form a colloidal solution. So beaker B has colloidal solution.

iv) The solution present in beaker A is homogenous.

Explanation: Only true solutions are homogenous in nature and solution in beaker A is true solution. Therefore solution in beaker A is homogenous while the solution in beaker B is heterogenous.

V) Beaker B

Explanation: The colloidal particles have a size range of 10Å to 2000Å and beaker B is having the colloidal solution. The particle size range for a true solution is 1Å to 10Å.

9. Question

Name the type of solution formed in the following cases:

i) 20g of NaCl in 100g of water.

ii) 36g of NaCl in 100g of water.

iii) 45g of NaCl in 100g of water at 80°C.

iv) Sulphur dissolved in CS_2

v) Nitrogen in the soil.

Answer

i) Unsaturated solution

Explanation: Solubility of NaCl at room temperature is 36g. It implies that 36g of NaCl is required to saturate 100g of water. But in this case we are adding only 20g and more of NaCl can be added. Thus it is an unsaturated solution.

ii) Saturated solution

Explanation: Solubility of NaCl at room temperature is 36g. It implies that 36g of NaCl is required to saturate 100g of water. So in this case we are adding 36g NaCl which is exactly the amount for saturated solution. Thus it is a saturated solution.

iii) Super-saturated solution

Explanation: A super saturated solution contains more solute than the saturated solution. In this case we have increased the temperature due to which the solubility increased. So more solute can be added. Thus it is a super-saturated solution.

iv) Non-aqueous solution

Explanation: A solution containing any liquid solvent other than water is called non-aqueous solution. In this case solvent is carbon disulphide (CS_2). Thus it is a non-aqueous solution.

v) Saturated solution

Explanation: Soil cannot store more nitrogen than it can hold and when no more solute can be added to a given amount of solvent then it is called saturated solution.

10. Question

Give the dispersed phase and the dispersion medium in each of the following:

a. cheese b. soda water c. Smoke

Answer

The dispersed phase and the dispersion medium are the two components of a colloidal solution. The substance distributed as particles is called dispersed phase and the continuous phase in which colloidal particles are dispersed is called dispersion medium.

The dispersed phase and a dispersion medium for given samples can be summarized as follows:

Samples	Dispersed phase	Dispersion medium
Cheese	liquid	Solid
Soda water	gas	Liquid
Smoke	solid	Gas

11. Question

Radha prepared a solution which could be separated by filtration.

i) Name the type of solution.

ii) Is the solution transparent or opaque?

iii) Mention the nature of the solution.

iv) Mention the size of the solute particle.

Answer

i) Suspension solution

Explanation: The only type of solution that can be filtered is suspension solution. This property is attributed to their large particle sizes which allow them to be filtered.

ii) Opaque

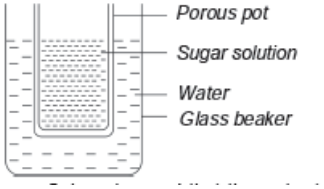
Explanation: Solute particles are insoluble in the solvent and remain suspended in the solution. Thus we cannot see through them and hence they are opaque.

iii) Heterogenous

Explanation: Suspension solutions are heterogenous mixtures in which the solute particles are not uniformly distributed in the solvent. Only true solutions are heterogenous in nature.

iv) The suspension solutions have the biggest particles which have the size greater than 2000Å. True solutions have the least particle size followed by colloidal solution particles.

12. Question



In the above case, Sekar observed that the water turned sweeter after sometime.

Explain the reason for the same.

Answer

The water turned sweet after sometime due to the process of diffusion. Diffusion is the movement of solute particles/molecules/ions from a region of higher concentration to a region of lower concentration.

In the above diagram, the concentration of sugar molecules is higher in the sugar solution and less in the water. So the sugar molecules get diffused from the region of higher concentration (sugar solution) to region of lower concentration (water). Due to this reason water turned sweeter after sometime.

13. Question

Beaker ‘A’ has chalk powder mixed with water and beaker ‘B’ has protein dissolved in water.

i) Which solution shows Brownian movement?

ii) Identify the solution that has particle size greater than 2000Å

iii) Which beaker contains colloidal solution?

iv) Mention the size of the particle present in beaker B.

v) Say whether colloidal solution is homogeneous or heterogeneous

Answer

i) Beaker B

Explanation: Chalk powder mixed with water is a suspension solution and protein dissolved in water is a colloidal solution. Brownian movement is a phenomenon of continuous random motion of colloidal particles. Therefore, beaker B shows Brownian movement.

ii) Solution in beaker A

Explanation: suspension solutions have particle size greater than 2000Å and colloidal solutions have particle size of 10Å to 2000Å. There the suspension solution present in beaker A has particle size greater than 2000Å.

iii) Beaker B

Explanation: The chalk powder dissolved in water gives a heterogenous mixture of suspended chalk particles in water whereas the protein dissolved in water gives a heterogenous mixture which is translucent in appearance. Therefore, beaker B has colloidal solution in it.

iv) Since the solution present in beaker B is a colloidal solution so the size of the particles of beaker B is 10Å to 2000Å

v) Colloidal solution is a heterogenous mixture. The composition is not uniform throughout the mixture. It

consists of two phases: dispersed phase and dispersing medium. The substance distributed as particles is called dispersed phase and the phase in which these particles are distributed is known as dispersing medium.

14. Question

Justify the following statements with an explanation:

i) Solubility of calcium oxide decreases with increase in temperature.

ii) What happens to the solubility in exothermic process with regard to temperature?

iii) In endothermic process, solubility increases with increase in temperature.

iv) At a given temperature, increase in pressure increases the solubility of the gas.

Answer

i) Addition of calcium oxide (CaO) to water is an exothermic process. For exothermic processes, solubility decreases with increase in temperature and that is why solubility of calcium oxide decreases with increase in temperature.

ii) In exothermic process, the solubility decreases with the increase in temperature. This means that when you will heat the mixture then solute will become less soluble. For example, amount of dissolved oxygen decreases in hot water.

iii) An endothermic process is a process in which we need to give heat to carry out the process i.e. heat is absorbed. For example addition of potassium nitrate (KNO_3) to water is an endothermic process. It means that we need to heat the mixture of KNO_3 and water to dissolve KNO_3 in water. This is so because on increasing the temperature the bonds of KNO_3 break more easily and thus it gets dissolved easily. In this way the solubility increases with increase in temperature.

iv) Solubility of a gas in a liquid increase with the increase in pressure. This can be justified with an example of solubility of CO_2 in soft drinks. Carbon dioxide is filled in soft drinks bottles at high pressure due to which it becomes highly soluble in the soft drink. When we open the bottle numerous times, the soft drink loses its taste because solubility decreases due to decrease in pressure.