Solution, Colloids, Suspension – Experiment, Viva Voce

Introduction

1. **Solution:** It is a homogeneous mixture of two or more substances. Solutions can be solid solutions e.g. alloys; liquid solutions e.g. lemonade and gaseous solutions e.g. air.
   A solution is made up of solute and solvent.
2. **Solute:** The component of the solution that is dissolved in the solvent is called the solute.
3. **Solvent:** The component of the solution that dissolves the other component in it is called solvent.

Concentration of a Solution

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

$$concentration\ \ of\ \ a\ \ solution\ \ =\ \ \frac{Amount\ \ of\ \ solute}{Amount\ \ of\ \ solution}$$

2. A solution is always transparent, light passes through it without scattering as the solute particles are very small in size. The solution is homogeneous and does not settle. A solution cannot be filtered but can be separated using the process of distillation. For example, a solution of sugar in water.
3. **Types of True Solution:** Depending on the nature of solute and solvent, we can get variety of solutions.
4. A suspension is cloudy and heterogeneous mixture. The particles are larger than the particles of solution and can be filtered. A suspension settles when it is allowed to stand for some time. The particles can be seen with the naked eyes.
5. The particles of a suspension scatter a beam of light passing through it and make its path visible.
6. A colloid particle size is intermediate between a solution and a suspension. It does not separate out on standing and cannot be filtered. Colloids show the Tyndall effect. Light passing through a colloid shows dispersion. It is homogeneous to naked eyes, e.g. milk.

Types of Colloids

S.No.	Solute	Solvent	Solution
1.	Solid	Solid	Alloy *e.g.* gold + copper solution
2.	Solid	Liquid	E.g. solution of salt in H_2O
3.	Liquid	Liquid	Ethanol in water
4.	Gas	Liquid	Cold drinks/ soda. CO_2 in water
5.	Gas	Gas	Oxygen and nitrogen

EXPERIMENT 2

Aim
To prepare:

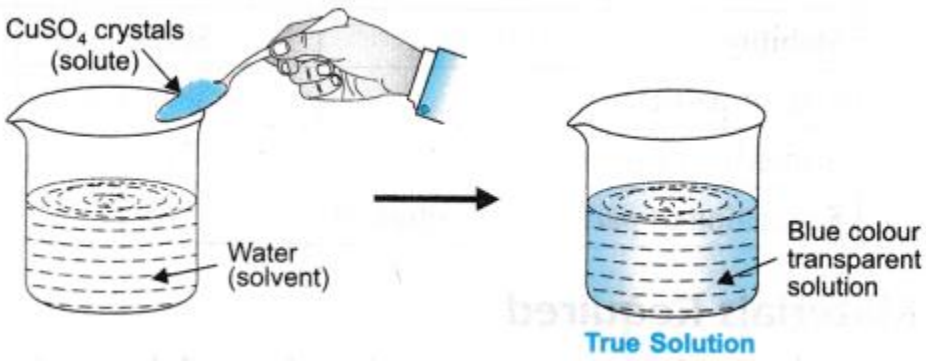
1. a true solution of common salt, sugar and alum in water.
2. a suspension of soil, chalk powder and fine sand in water.
3. a colloidal solution of starch in water and egg albumin in water and distinguish between these on the basis of:
    - transparency
    - filtration criterion
    - stability

Theory

1. **True solution:** A solution that has solute particles of size smaller than 1 nm (10^{-9} metres) in diameter, and cannot be seen with naked eyes. They do not scatter a beam of light, the particles do not separate by filtration and the particles do not settle down.
2. **Suspension:** It is a heterogeneous mixture in which solute particles do not dissolve but remain suspended, particles can be seen with naked eyes, it scatters a beam of light, particles can be separated from the mixture by filtration.
3. **Colloidal solution:** The solution appears to be homogeneous, the particles can scatter a beam of light, they do not settle down when left undisturbed, it is stable and particles cannot be seen by naked eyes. The particles cannot be filtered. The size of particles is between 10^{-7} cm to 10^{-4} cm in diameter.

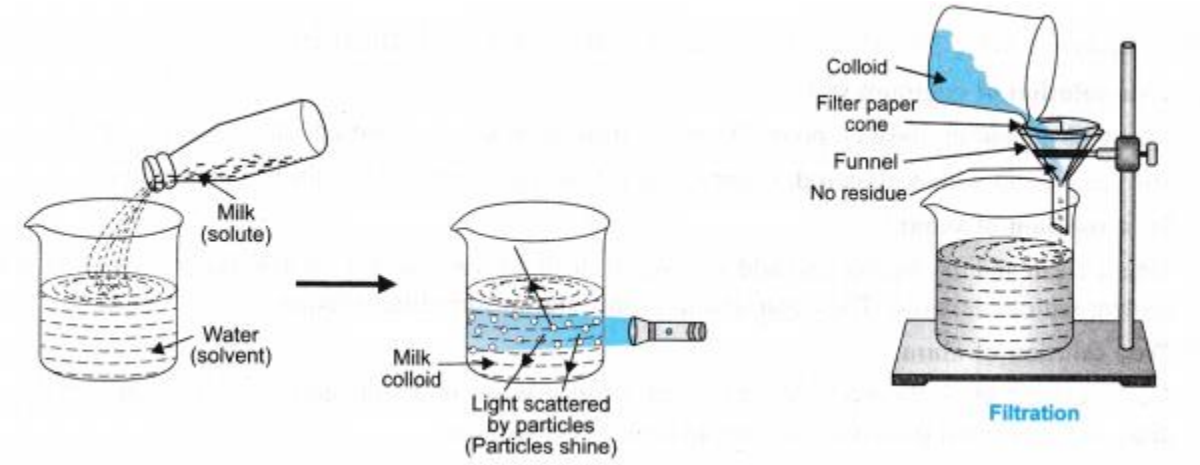
Properties of True Solutions

1. A true solution is a homogeneous mixture of solute and solvent.
2. The particle size of solute is less than 1 nm (1 nm =10^{-9}m).
3. The components do not scatter light and do not show Tyndall effect.
4. The particles cannot be separated by filtration.
5. The solution is stable (remains uniform).
6. The solution is transparent.



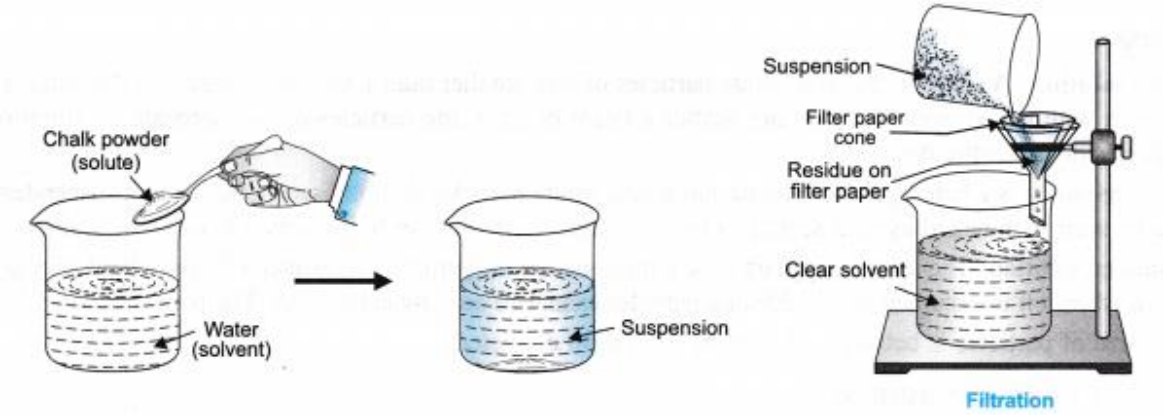
Properties of Colloid

1. It is a heterogeneous solution but appears to be homogeneous.
2. The particle size of solute is 1 nm-1000 nm. (10^{-9}-10^{-6} m)
3. The components scatter light and shows Tyndall effect.
4. The particles can be separated only by centrifugation.
5. The solution is stable.
6. The solution is translucent.



Properties of Suspension

1. It is a heterogeneous mixture.
2. Particle size is more than 1000 nm (10^{-6} m) and can be seen with naked eyes.
3. The particles of suspension, in its suspended form scatter a beam of light, i.e., shows Tyndall effect.
4. It is unstable.
5. The particles can be separated by filtration.
6. It is opaque.



Properties	True Solution	Suspension	Colloid
Stability	Stable	Unstable	Stable
Size of particle	Less than 1 nm	More than 1000 nm	10^{-7} cm to 10^{-4} cm in diameter
Scattering of light	No	Yes	Yes
Separation of particles by filtration	No	Yes	No

Materials Required

1. Beakers (250 mL), an iron stand, a glass rod, Bunsen burner, test tube stand, three funnels, three tripod stands, filter papers, a small torch and China dish.

Chemicals Required

1. Common salt, sugar crystals, alum powder, chalk powder, fine sand, raw egg, fine soil from garden and distilled water.

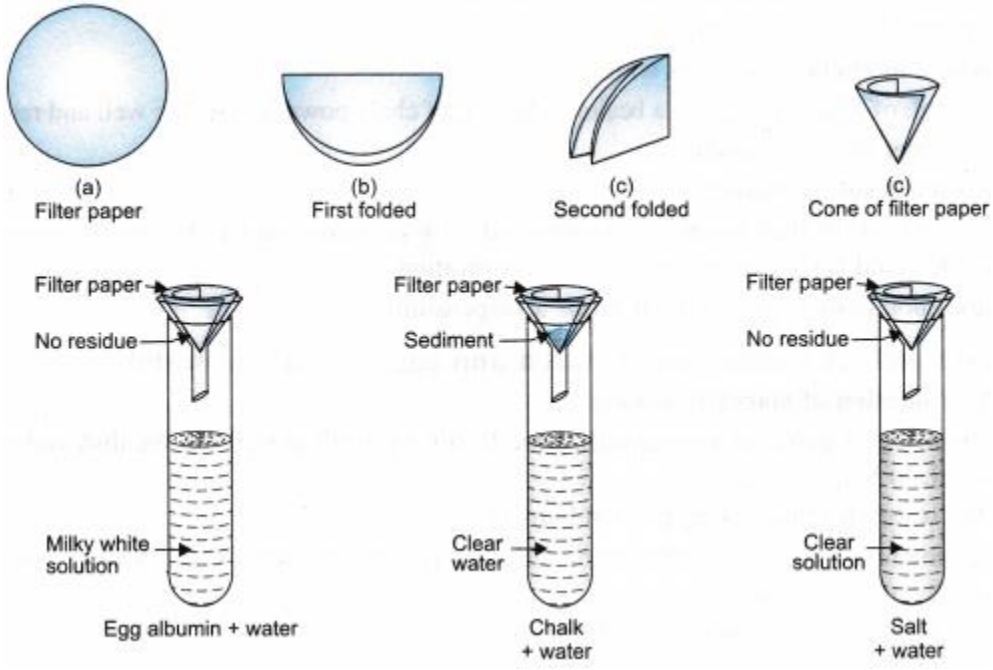
Procedure

1. **To prepare a true solution of common salt, sugar and alum in water.**
   - **True solution of common salt:**
     Take a clean and dry beaker, pour 100 mL of distilled water in it and add dry common salt in it.
     Stir the content with a glass rod. Common salt dissolves completely to form a true solution.
   - **True solution of sugar:**
     Take a clean and dry beaker and add 100 mL of distilled water in it, pour few sugar crystals in it arid stir the content with a glass rod. The sugar dissolves in water to form true solution.
   - **True solution of alum:**
     Take a clean and dry beaker, add 100 mL of distilled water in it and add a pinch of alum powder, stir with a glass rod. The alum dissolves in water to form a true solution.
2. **To prepare a suspension of soil, chalk powder and fine sand in water.**
   - **Suspension of sand in water:**
     Take 100 mL of distilled water in a beaker, add 10 g of fine sand in it. Stir well using a glass rod. Allow it to stand for some time and record your observation.
     (It does not dissolve in water)
   - **Suspension of chalk powder in water:**
     Take 100 mL of distilled water in a beaker, add 10 g of chalk powder in it. Stir well and record your observation,
     (chalk + water forms a suspension)

- **Suspension of soil in water:**
  Take 100 mL of distilled water in a beaker and 10 g of garden soil to it. Stir the mixture with a glass rod. Allow it to stand for some time record your observation.
  (Soil does not dissolve in water but forms a suspension)

3. **To prepare colloidal solutions of starch and egg albumin in water.**
   - **Colloidal solution of starch in water:**
     Take about 1 g of starch in a china dish, pour 10 mL of distilled water in the dish and stir the mixture. Now take 90 mL of hot, boiling water.
     (Heat the water in beaker using Bunsen burner)
     Stir the contents of the china dish continuously and pour the contents in the boiling water. Allow the contents to cool. Record your observation.
     (The starch + water solution is colloidal in nature.)
   - **Colloidal solution of egg albumin in water:**
     Take 10 ml of water in a beaker. Break an egg and discard the egg shells. Separate the white portion of egg from the yellow part. Add a very small quantity of egg albumin to it. Stir the contents thoroughly with the help of a glass rod. Then add 90 mL of distilled water with continuous stirring and few drops of dil. acid (dil. HCL, dil.H_2S0_4). Record your observation.
     (Egg albumin + water solution is colloidal in nature.)
4. **To distinguish the above formed solutions on the basis of transparency, filtration criterion and stability:**
   Take one true solution —> salt + water
   Take one suspension —> chalk + water
   Take one colloidal solution —>egg albumin + water
   - **Transparency:**
     Take 3 test tubes with a colloid, suspension and true solution in each respectively. Paste a white paper with tick mark on one side of each test tube. Look at the tick mark through the contents of the three test tubes from the other side. Check for the transparency of tick mark.
     Record your observations.
   - **Filtration Criterion:**
     Take 3 tripod stands, place a funnel over each stand. Fix the filter paper in

the funnel and check for the filtration criterion. Record your observations.



- **Stability Criterion:**
  Take 3 test tubes with a colloid, suspension and true solution in each respectively. Shake all the test tubes and keep them in the test tube stand, allow it to stand for 5 minutes.
  Record your observations.

Observation Table

S.No.	Property	True Solution	Colloidal Solution	Suspension
1.	Size of Particles	Less than 10^{-9} m	Between range of 10^{-9} m – 10^{-6} m	More than 10^{-6} m
2.	Nature	Homogeneous	Appears homogeneous but is heterogeneous.	Heterogeneous
3.	Visibility	The solute particles are invisible to naked eye and also under the microscope.	The solute particles are invisible to naked eye but can be viewed under powerful microscope.	The solute particles are visible to naked eye.
4.	Stability	The solute particles do not settle down and are stable.	The solute particles do not settle down and are stable. (On centrifugation the particles can settle)	The solute particles settle down and are unstable.
5.	Filtration	The solute particles can pass through filter paper and no residue is seen on filter paper.	The solute particles passes through filter paper and no residue is left. (But the particles cannot pass through parchment membrane)	The solute particles can not pass through filter paper and residue is collected on filter paper.
6.	Transparency	Transparent	Translucent	Opaque

Precautions

1. Use test tube holder for heating/boiling of water.
2. Do not waste the chemicals and distilled water. Use it wisely.
3. Always stir the contents in the test tube nicely and gently.
4. Use only distilled water to make solutions.

VIVA VOCE

Question 1:
Give one example of liquid solution.
Answer:
lemonade + water.

Question 2:
Give one example of gaseous solution.
Answer:
Air.

Question 3:
Give one example of solid solution.
Answer:
Alloys: Brass—30% Zinc and 70% copper.

Question 4:
Name the solute and solvent in sugar solution.
Answer:
Solute —> sugar Solvent -> water.

Question 5:
Name one solution that has gas as solute.
Answer:
Soda water, solute is $C0_2$, solvent is water.

Question 6:
What is tincture of iodine solution?
Answer:
A solution of iodine in alcohol is ‘tincture of iodine’.

Question 7:
What is the size of particles in true solution?
Answer:
The size is less than 1 nm (10^{-9} metre) in diameter.

Question 8:
Why does a true solution not scatter a beam of light?
Answer:
Due to very small particle size, it does not scatter a beam of light.

Question 9:
What is Tyndall effect? .
Answer:
The scattering of beam of light is called Tyndall effect.

Question 10:
How can you separate colloidal particles from its solution?
Answer:
By centrifugation.

Question 11:
Name three types of colloids.
Answer:
Aerosol, foam, emulsion.

Question 12:
Give two examples of Aerosol.
Answer:
Fog, mist.

Question 13:
Give two examples of foam.
Answer:
Shaving cream, rubber.

Question 14:
Give two examples of emulsion.
Answer:
Milk, face cream.

Question 15:
What is concentration of solution?
Answer:
The amount of solute present in a given solution.
Question 16:
Give the chemical formula of sugar and alum.
Answer:
Sugar – sucrose ->$C_{12}H_{22}O_{11}$
Alum – K_2S0_4. $A_{12}(S0_4)_3.24H_20$

Question 17:
What will you name the heterogeneous solution whose particle size is between 10^{-7} cm to 10^{-4} cm?
Answer:
It is a colloidal solution.

PRACTICAL BASED QUESTIONS

Question 1:
What are saturated and unsaturated solutions?
Answer:
A solution which cannot dissolve more solute at a given temperature is called a saturated solution. A solution which can dissolve more of the solute at a given temperature is called an unsaturated solution.

Question 2:
Why do we use warm water and not hot water during the preparation of a colloidal of egg albumin?
Answer:
The protein in egg albumin coagulates to form a lump in hot water.

Question 3:
What precaution should you take while preparing starch solution?
Ans. We should always prepare starch paste and then dissolve it in hot water.

Question 4:
What is an aqueous solution?
Answer:
A solution in which water is the solvent.

Question 5:
Give one use of suspension.
Answer:
Suspensions are used in medicines.

Question 6:
What is dispersed phase and dispersing medium?
Answer:
The medium in which a colloid is formed is called the dispersing medium. The insoluble component in the medium is called the dispersed phase.

Question 7:
Give three examples of solvents, commonly used.
Answer:
Water, acetone, alcohol.

Question 8:
Why is water called a universal solvent?
Answer:
Water is called universal solvent as maximum number of substances dissolve in it.

Question 9:
How can you make a saturated solution unsaturated?
Answer:
Saturated solution on heating becomes unsaturated.

Question 10:
How can you make unsaturated solution saturated?
Answer:
The unsaturated solution on cooling/freezing can become saturated.

Question 11:
What is the dispersed phase and dispersing medium in foam?
Answer:
In foam, the dispersing medium is liquid and dispersed phase is gas—for e.g. shaving cream.
Or
When dispersing medium is solid and dispersed phase is gas then foam is formed for e.g., rubber, sponge.

Question 12:
To make a solution, 40 g of common salt is dissolved in 280 g of water. Calculate its concentration in terms of mass by mass percentage of the solution.
Answer:
Mass of solute = 40 g
Mass of solvent = 280 g
Mass of solution = Mass of solute + Mass of solvent.
= 40 g + 280 g = 320 g
$Mass \quad percentage \quad of \quad solution \quad = \quad \frac{Mass \quad of \quad solute}{Mass \quad of \quad solution} X100 = \frac{40}{320} X100 = 12.5$

Question 13:
A saturated solution was obtained at 25°C. What will happen if it is kept in 40°C condition?
Answer:

The solution will become unsaturated, because the solubility increases with the rise in temperature.

NCERT LAB MANUAL QUESTIONS

Question 1:
Why are the particles of a true solution not visible to naked eye?
Answer:
The particles of true solution are very small to be seen with naked eye.

Question 2:
What is the order of the size of a particle that can be seen by naked eyes?
Answer:
The particles with the size order of 1000 nm or more are visible through our naked eye.

Question 3:
What different techniques of separation can be employed for separation of components of homogeneous and heterogeneous mixture?
Answer:
Homogeneous mixture: can be separated by evaporation, distillation and fractional distillation.
Heterogeneous mixture: can be separated by filtration, centrifugation, sedimentation and decantation.

Question 4:
What will be your observation, when a beam of light is passed through a true solution and through a suspension respectively?
Answer:
A beam of light will pass straight without scattering in case of true solution. When the suspension is settled it will not disperse the beam of light flashed on it but when the suspension is not settled the beam of light will scatter and the path of light will become visible.

Question 5:
What will be the effect of passing light through colloidal solution of sulphur?
Answer:
When light is flashed on the colloidal solution of sulphur it will be scattered.

Question 6:
What is the difference in the particle size of colloid, true solution and suspension?
Answer:
The size of particles in true solution is less than lnm, the size of colloidal particles is in the range of lnm to 1000 nm and the size of suspension particles is more than 1000 nm.

Question 7:
Classify the following as a true solution, as a suspension, or as a colloid:

1. milk
2. CuS04 solution;
3. jam;
4. gum;
5. soil in water and
6. sand in water.

Answer:
True solution: $CuS0_4$, solution;
Colloid: Milk, gum, jam,
Suspension: Soil in water and sand in water.

MULTIPLE CHOICE QUESTIONS (MCQs)
Questions based on Procedural and Manipulative Skills

Question 1:
The particle size of true solution is
(a) less than 10^{-5}m
(b) less than 10^{-9} m
(c) more than10^{-5} m
(d) between 10^{-7} m and 10^{-5} m.

Question 2:
Which will not give a stable solution even when stirred for some time?
(a) Sugar in water.
(b) Milk in water.
(c) Ink in water.
(d) Chalk powder in water.

Question 3:
To prepare a colloidal solution of starch, we should
(a) add starch powder to boiling water and oil.
(b) add starch powder to cold water and boil.
(c) add starch powder to boiling water and boil.
(d) add thin paste of starch to hot water with stirring.

Question 4:
In jelly, the dispersed phase and dispersing medium are
(a) liquid and solid respectively
(b) solid and liquid respectively

(c) solid and solid respectively
(d) liquid and gas respectively.

Question 5:
In a homogeneous mixture, the size of particles is too small to be seen by naked eyes, the particles do not settle down, the solution can be
(a) colloid
(b) true solution
(c) both (a) and (b)
(d) information is insufficient.

Question 6:
The colloidal solution in which both the dispersed phase and dispersing medium is liquid is called
(a) Gel
(b) Emulsion
(c) Foam
(d) Aerosol.

Question 7:
Which of the following cannot pass through filter paper?
(a) True solution
(b) Colloidal solution
(c) Suspension
(d) None of these.

Question 8:
The particle size in suspension is
(a) more than 10^{-7} cm
(b) less than 10^{-7} cm
(c) between 10^{-7} cm and 10^{-5} cm
(d) more than 10^{-5} cm.

Question 9:
A solution of iodine in alcohol is known as tincture of iodine, in this solution
(a) iodine is solvent and alcohol is solute.
(b) iodine is solute and alcohol is solvent.
(c) iodine and alcohol is solute and water is solvent.
(d) none of these.

Question 10:
Which of the following is stable when allowed to stand undisturbed for some time?
(a) Sugar solution
(b) Solution of starch in water.

(c) Milk
(d) All of the above.

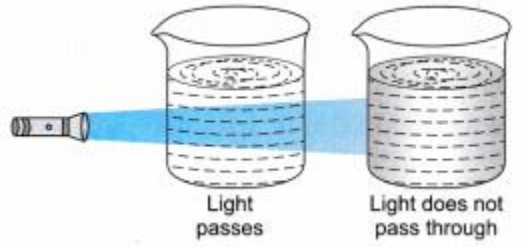
Question 11:
Which will not give stable solution even when stirred for some time?
(a) Common salt in water
(b) Sugar in water.
(c) Milk in water.
(d) Fine sand in water.

Question 12:
The order of the size of a particle that can be seen by naked eye is
(a) less than 10^{-5} cm
(b) more than 10^{-5} cm
(c) less than 10^{-9} cm
(d) more than 10^{-9} cm

Questions based on Observational Skills

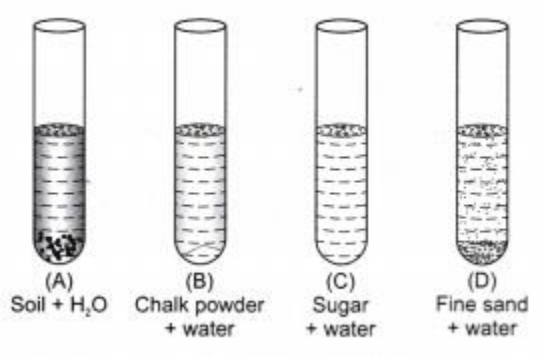
Question 13:
A student was asked to mix the white of an egg with water and stir well. The student observed that:
(a) a transparent solution is formed
(b) a translucent mixture is formed
(c) egg white settles down at the bottom
(d) egg white floats on the surface.

Question 14:
The proper sequence of the contents in the glass beaker is



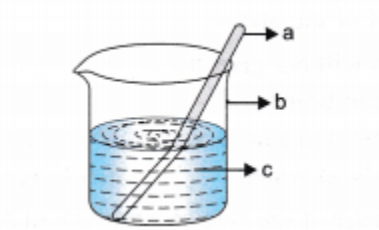
(a) suspension and true solution
(b) colloid and suspension
(c) true solution and suspension
(d) colloid and true solution.

Question 15:
Four students took 4 test tubes A, B, C, D. They added soil, chalk powder, sugar, fine sand with water in the test tubes as shown below. The correct observation is



(a) A, B, D are suspension
(b) B, C, D are suspension
(c) C, B, A are suspension
(d) A, B, D are not suspension.

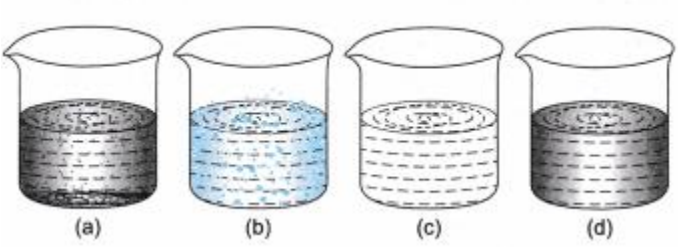
Question 16:
For preparing a true solution, the given set up was done. What is ‘a’, ‘b’ and ‘c’?



(a) a = glass rod, b = solution, c = beaker
(b) a = glass rod, b = beaker, c = solution
(c) a = beaker, b = solution, c = glass rod
(d) a = beaker, b = glass rod, c = solution

Question 17:
The particles of colloidal solution are
(a) visible with naked eye
(b) visible with powerful microscope
(c) not visible with powerful microscope
(d) none of these

Question 18:
Which of the following is a true solution?



(a) sand

(b) soap
(c) milk
(d) alcohol

Questions based on Reporting and Interpretation Skills

Question 19:
Which of the following solution shows Tyndal effect?
(a) true solution
(b) starch and water
(c) sugar + water
(d) alum + water.

Question 20:
The substance which does not form a suspension in water is:
(a) common salt
(b) sand
(c) soil
(d) chalk powder.

Question 21:
Which of the following shows Tyndall effect?
(a) salt solution
(b) sugar solution
(c) sand into water
(d) none of these.

Question 22:
The particles of a (matter) solution cannot be separated by filter paper but can be separated on centrifugation, the solution must be
(a) true solution
(b) suspension
(c) colloidal
(d) none of these.

Question 23:
Milk and blood are the example of
(a) colloidal solution and suspension respectively
(b) both colloidal solution
(c) suspension and colloidal solution respectively
(d) both are suspension.

Question 24:
Which of the following is stable when allowed to stand undisturbed for some time?
(a) sugar solution
(b) salt solution
(c) alum solution
(d) all of these.

Question 25:.
In the given solutions choose the one that is unstable
(a) water + honey
(b) water + chalk
(c) water + $CuS0_4$
(d) water + alcohol.

Question 26:
A mixture of soil and water was shaken well and then tested for its appearance, stability and sedimentation. The correctly reported set of observation is
Appearance Stability Sedimentation
(a) opaque unstable sediment
(b) opaque stable sediment
(c) Transparent unstable no sediment
(d) Transparent stable no sediment

PRACTICAL SKILLS IN SCIENCE-9

Question 27:
True solutions do not show Tyndall effect because
(a) they allow light to pass through them.
(b) they have very small size of particles
(c) they allow the light to scatter.
(d) none of these.

Question 28:
Which one of the following will form a translucent solution in water?
(a) sugar
(b) starch
(c) soil
(d) sand

Question 29:
When starch is added to water it forms
(a) colloid
(b) suspension

(c) true solution
(d) none of these

Question 30:
Which type of solution is formed when sand and water are mixed thoroughly and then kept undisturbed for some time?
(a) true solution
(b) suspension
(c) colloid
(d) none of the above

Question 31:
Which of the following settles down when allowed to stand undisturbed for some time?
(a) Blood
(b) solution of egg albumin in water
(c) Muddy water
(d) copper sulphate solution

Question 33:
Tyndall effect is observed in one of the following:
(a) true solution
(b) starch + water
(c) NaCl + water
(d) alum + water

Question 34:
A student observed the colloidal solution of starch in water and milk. The wrong conclusion made by him for both the solutions is:
(a) Translucent
(b) Shows Tyndall effect
(c) Homogeneous and stable
(d) Components cannot be separated by ordinary federation

Question 35:
The colloid among the following is
(a) NaCl $+H_20$
(b) soil in water
(c) jam
(d) alcohol in water

Question 36:
The correct order which describes the true solution, colloidal solution and suspension in the order of their increasing stability is:
(a) Suspension < colloidal solution < true solution

(b) Colloidal solution < true solution < suspension
(c) True solution > colloidal solution < suspension
(d) Colloidal solution < suspension < true solution

SCORING KEY WITH EXPLANATION

1. (b) Size of particles in true solution is the same.
2. (d) Size of particles is big.
3. (d) The starch will mix well in hot water.
4. (a) Dispersed phase is liquid.
5. (c) Both colloid and true solution have these properties.
6. (b) In an emulsion, both the dispersed phase and dispersal medium are liquid.
7. (c) Particles of suspension are big enough to pass through filter paper.
8. (d) This is the size of suspension particle.
9. (b) Iodine does not dissolve in water hence alcohol is used as solvent.
10. (d) None of them is suspension. True solution and colloid are stable.
11. (d) Sand in water is unstable.
12. (b) This size is visible to naked eye.
13. (b) Egg white is translucent.
14. (d) Light doesn't passes through solution and disperse in colloid.
15. (a) In all three test tubes, the particle size is big and is unstable.
16. (b) The apparatus is rightly labelled.
17. (b) Colloid particles are not visible to naked -eye.
18. (d) Alcohol in water is a true solution.
19. (b) Particle size of starch is between 1 nm to 1000 nm, it scatters light, it is a colloid.
20. (a) Common salt dissolves completely and has very small particle size, cannot be seen with naked eyes.
21. (d) None of the given option is colloid.
22. (c) Colloid particles can pass through filter paper but settles on centrifugation.
23. (b) Both milk and blood are colloids.
24. (d) All are true solutions and stable.
25. (b) Chalk particles are big and settle down.
26. (a) Soil particles are big enough and opaque to pass the light through it and due to gravity will settle down.
27. (b) Small particle size does not scatter light.
28. (b) Starch forms a colloid.
29. (a) Starch forms a colloid, it scatters light.
30. (b) Sand particles are big in size and settle down.
31. (c) Particles of muddy water are big in size and settle down due to gravity.
32. (d) Detergent powder is completely soluble in water.
33. (b) Starch forms a colloid in water (hot water).
34. (c) Both are stable and particle size is very small but colloidal solution are heterogeneous.
35. (c) Jam is a colloid, type of colloid is gel, containing solid and liquid mixture.
36. (a) Larger the size of particle lesser will be the stability.