Is Your Solution Same As mine?

Introduction

Most of the liquids we see around us are solutions or mixtures having more than one substance in it. For example, the water you get in a tap or a hand pump, is not pure water, but is a solution containing several salts and some gases.

Yet we don't see that water as a salt solution. But if the water has a lot of salt in it like sea water we call it salty water or salt solution. Thus in our common life, the amount of dissolved substance makes us label the liquid as a pure substance or a solution. In fact, in most daily life needs, we prefer solutions over pure substances. This is because many properties of solutions can be changed more easily according to our needs than properties of pure substances. Most chemical reactions happen in solutions. Most biological processes including digestion of food also take place in solutions.

Solution is a mixture of solute and solvent. The component which is in less quantity is usually called 'solute' and component in high quantity is usually called 'solvent'.

But can we say one salt solution is the same as another salt solution? Usually the standard way of identifying a solution is by the name of the solute (like salt) in it and its concentration. In this unit, we will try to understand the meaning of concentration of a solution and its effects of properties of solution.

Overview: Solutions are so common around us that it is very difficult to find a pure liquid (element or compound) in nature. Most students can understand the concept of a solution, but many students struggle with understanding the significance of concentration values expressed for a solution. Further confusion arises due to multiple units used for expressing concentrations of different solutions. One way to help a student understand the significance of concentration is to realize that many properties of solutions change with concentration of solute(s) in it. Some experience of change in properties of solutions with concentration can help students understand the significance of mass and volume measurements needed to express the solution concentration.

The unit starts with a planning exercise of how to make a summer drink for certain number of persons. This exercise helps students to start thinking about amounts to be mixed in certain proportions to make the drink. In tasks 2 and 3, student prepare solutions of different concentration and changes in properties such as solution's volume, density, resistance to flow (viscosity), and apparent bending of object partially immersed in it (due to change in refractive index). Further if some solutions become hazy due to some suspended impurities, the opacity of solutions also changes with concentration. Next in tasks 4 and 5, students can learn about concentration values of solutions which they may encounter in daily life, what the values signify.

Minimum time required : 4 sessions of 40 minutes

Type of learning unit : Classroom/Laboratory

Unit specific objectives:

1. To understand the idea of concentration of solute in a solution as proportion of amounts in informal and formal units.
2. To see evidence of concentration of solute(s) in a solution affecting the properties of the solution.
3. To observe and get a sense of volume changes during dissolution.
4. To get a sense of why concentration of a solute in solution is important in different contexts.

5. To think about the situations where solutions are prepared in different contexts like agriculture, pharmaceuticals etc.
6. To think and appreciate when different types of mass and volume measuring instruments are used while preparing solutions. (Extension tasks)

Links to curriculum

NCERT Class 9 science – Is matter around us pure?

Task 1: Is your sherbet same as mine?

Imagine you need to prepare a drink for you and your 3 more friends using a ready made fruit syrup/ drink mix powder and drinking water. You can add salt/ sugar in addition if required.

Q1. How much quantity of final drink does your group need?

_____

Q2. What quantity/amount of fruit syrup/ drink mix powder will your group take? How much water will you mix?

_____

Q3. How will you measure the required quantities/amounts of
(i) fruit syrup/ drink mix powder
(ii) Water

_____

_____

Based on your answers for Question 1 to 3, complete the following table:

Group Number	Quantity of squash/juice	Quantity of water added	Quantity of the final drink

Table 1

Q4. If another friend of yours needs to prepare a drink exactly the same as yours, what instructions/recipe you will tell to your friend?

_____

_____

Students may also discuss if the quantities are realistic for a good taste.

This task tries to bring the ides that concentration is essentially a ratio of quantity (ies) of solute to either that of solvent or that of the final solution.

Task 2: Preparing Lemonade with seeds!

You may have prepared lemonade in summers by mixing lemon juice and sugar in cold water as a cooling drink. In this task, you will prepare the lemonade with lemon seeds in it to discover an interesting property of the lemonade.

Generally, it is not advisable to consume any drinks/ solutions prepared in these tasks. Any Solution can be tasted if and only if 1) drinking water is used as solvent. (2) You are not working in chemistry lab.(3) Equipments and containers you used for this experiment are not used in the Chemistry lab.

Materials Required: Sugar- 50g, lemon- 1, two identical transparent glasses, spoon- 1, Knife (to cut lemon), drinking water

Preparation:

1)Take 2 identical transparent glasses labeled as A and B and add approximately same amount of lemon juice along with the seeds into A and B (do not remove seeds).

2) Add equal amount of water in each glass (to fill it approximately half). Check the water level by bringing your eye at the water level.

Q1. Where can you find the seeds in the glass (top/bottom/middle)?

_____

> Seeds remain at the bottom of the glass. But some seeds may float if it is damaged (hollow or deformed from inside).

3) Add 1 teaspoon of sugar to glass B. Stir it with the help of the spoon till it dissolves.

Q2. Now, where can you find the seeds in the glass B? (Top/bottom/middle)

_____

> Seeds change the position from the bottom to middle / top of the glass.

4) Add 1 more teaspoon of sugar to glass B. Stir it with the help of the spoon till it dissolves.

Q3. If the seeds are still not at the top of glass B, how much sugar must be added to bring the seeds to the top?

_____

Q4. In your opinion why the seeds in B start floating but not in A? Something changes in seeds or in solution?

_____

_____

> Objects with lower density than their surrounding fluids float, while objects with higher density sink. The density of lemon seeds is only slightly higher than the water because of which it remains at the bottom of the glass at first. Dissolving the sugar in water increases the density of solution as there is an increase in mass in a given volume. When the solution's density exceeds the lemon seed's density, it starts floating. You can also correlate it with the example of dead sea where due to higher density of its water than other seas, humans can easily float.
>
> Please note that for most solutions, density of solution increases with concentration of solute. However, there are few substances for which, the density of their aqueous solutions decreases with increase in concentration (example, solutions of ammonium hydroxide in water and ethanol in water).

Q5. Can you think of the number of solutes present in the prepared lemon juice?

_____

Q6. What did we learn from the above observations of seeds sinking and floating?

_____

_____

5) Add half the amount of initially added water into beaker B again.

Q7. Now, where can you find the seeds?

_____

Q8. How much more sugar you may need to add to bring the seeds again at the top of the glass?

_____

6) Add sugar and dissolve it until the seeds come to the top of the glass.

Q9. How much sugar you added to bring the seeds to the top of the glass?

_____

Q10. Is there any relationship between the amount of water added and the sugar in both the cases before and after step 5)?

_____

_____

Task 3: What all can sugar do to a solution?

In this task, you will add different quantities of sugar to same amount of water, and discover some changes which it can cause to the water solution through three kinds of observations.

Materials required: transparent glass/ beaker (100ml)- 4, spoon/ any other small volume measuring cup/medicinal bottle cap -1, sugar- 40g, light weight items (ajwain, mustard seeds etc), stop watch- 1, glass rod- 1, 100ml measuring cylinder -1, pen refill/toothpick/small stick -1, white paper-1, marker pen.

Procedure:

1. Measure 60 ml of water using measuring cylinder and take in 3 transparent glasses/ beakers labelled as (i), (ii) and (iii). Mark the level of water in each.
2. Then, add 1, 2 and 4 teaspoons of sugar in (i), (ii) and (iii), respectively. Stir it till the sugar dissolves.

Observation 3 A. (**Less or more**) Notice the level of solutions in the three beakers. (Place white paper in background for better clarity)

Q1. Is it the same, higher or lower than the mark you made before adding sugar? Is there a pattern in the volumes in the three beakers? Can you think of any explanation for your observations?

_____

_____

> For this solution, volume increases with concentration of the solute. Mass is conserved here, but volume is not.

Q2. To calculate concentration of sugar solutions, would be better to take volume of water taken or the final volume of solution?

_____

_____

> Usually the final volume of the solution is taken. In some situations, the initial volume of water is also taken to estimate the concentration of the solution.

Observation 3 B. (**Slow or fast**) Stir the above solutions specific number of times (say 5 times), remove the stirrer and immediately start the stopwatch. Stop the stop watch when the particle comes to rest. Note down the time taken by solution to come to rest.

> If there is a difficulty in differentiating, whether solution is in rest or motion, add light weight particles such as ajwain, mustard before starting the stirring.

4. Repeat step 3 for remaining solutions.
From the above observations, fill the following table:

SOLUTION	TIME (min / s)
i	
ii	
iii	

Table 2

Q3. According to you, why the time taken by (i), (ii) and (iii) to come to rest changes from one another?

_____

_____

> This property depends on what is known as viscosity of a liquid, and as seen above, viscosity may depends on the amount of a solute in a solution. More precisely, It depends on the concentration of the solution.

Observation 3C: (Same or distorted) Put a refill/ small stick inside the three solutions and look at it from the side/ front (not from the top). For clarity, you can keep white paper behind these solution containers.
Q4. What do you observe? Is there any difference in shape of refill/toothpick/small stick observed in the three solutions?

_____

_____

> The refill/ tooth pick appears to bend at the solution - air interface. Usually this increase in the bending of refill/ tooth pick from beaker (i) to beaker (iii). The amount of sugar in beaker (iii) is more than beaker (ii) and beaker (i) which resulted in the increase of concentration of sugar in the solution.

Q5. Have you seen such apparent change in shape of objects in a liquid? Can you think why it happens?

_____

_____

> Optical illusion is due to bending of light in different media. This phenomenon is known as refraction or refractivity. The speed of light is different in different media (solutions (i),(ii) and (iii)). The intensity of the incident light decreases as the thickness of the absorbing medium increases, that is the concentration of the solution.

Optional task: Opacity

Additional material required: Graph paper

1. Place a 4 cm wide strip of a graph paper and place the solutions (i), (ii) and (iii) next to each other on the strip.
2. Try to see the paper through the solutions (i), (ii) and (iii) from the top.

Do you see any difference in the image in each of these three situations? If so, why?

_____

In general, true solutions are transparent to light. However in many common solutions like that of table sugar, opacity can be easily noticed which increases with concentration. It is due to the impurities present in the commercial sugar. In such situation this opacity can be an indicator of the concentration of the solution.

Task 4: Reading concentration labels

Teacher may bring some empty packets of food items or household solutions such as empty bottles of containers of cleaning solutions.

Now that you have seen how concentration of solute change change some properties of solutions, let us try to make sense of concentration values given on packets of household items sold in market.

Ingredient list of an oral re-hydration salt (ORS) powder is given below;

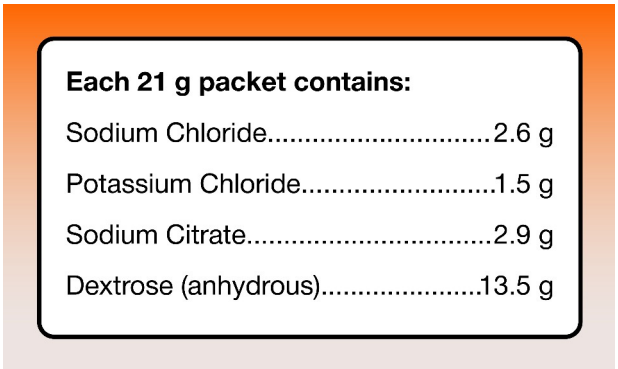

Image 1

Q1. Can you express the mass percentage of Sodium chloride content in the given packet?

_____

_____

Q2. The direction of usage is 1 tablespoon (4 gms) in 200 ml water. If you consume this ORS, how much of Sodium Chloride will enter into your body?

_____

_____

Read and write the composition of ingredients mentioned on carton / wrapper of juice or drink packets or packets of any other house hold items.

Packet (sample) name _____

Sr. No.	Ingredients	Quantity	Concentration/ Percentage

Table 3

If the concentration/percentage is already given in the carton, think about the different terms in which quantity and concentration of ingredients in the solution is expressed.

Task 5: Solution Concentrations in different professions

For water used in irrigation and construction, salinity and sodicity are considered as very important parameters. Salinity is the dissolved salt concentration in water and sodicity refers to sodium ion concentration in water. These properties can affect the nature of irrigated soils, for example soil can become hard, clumpy or it can develop cracks over time.

Q1. Try to find out the salinity and sodicity values of water used in irrigation in your district/state? Is there any impact of these water qualities in the soil?

_____

_____

> Students can try talking to the elders, and to get information from the state agricultural and state water supply departments including their websites.

Q2. Can you think of other professions where the concentration of solute in solution plays an important role? Such that any mistake in concentration can lead to unexpected/unwanted incidences. Do you know any such incident?

_____

_____

_____

> The use of saline in medical field, amount of preservatives in food industry, the concentration of dye used in the colouring of fabrics, concentration of cleaning agents.

Possible Extensions

Task 6: Dissolution and Volume Changes

Q1. Consider a 500 mL bottle filled with 500 ml of water. What will happen to the water level after the addition of 50 g of sugar(or any other instant powder drink mix). Will it be the same/ low / high?

_____

Let us see is there any change in volume of solution during dissolution.

Materials required: chemical balance, measuring cylinder(25mL), butter paper, small spoon or spatula, Stirrer (Long glass rod or plastic rod...longer than the height of the cylinder), beaker (50 mL or 100mL), dropper, water, Sugar, white paper (plain notebook page).

Prepare Sugar solution as follows;

Step 1. Take about 2 g Sugar on butter paper. Note down the exact weight.

Step 2. Take about 20 mL of water in a measuring cylinder with the help of a beaker. Add water drop by drop (using dropper) to make exactly 20mL. Note down the reading, V1 mL. Place a white paper behind the measuring cylinder in case if the readings are not visible.

Step 3. Carefully add 2 g weighed Sugar in the 20 mL water in the cylinder (roll the butter paper while transferring solid, don't allow sugar to stick on the sides of cylinder)

Step 4. Note the volume mark on measuring cylinder to which water level has risen just after adding solid sugar (V2 mL).

Step 5. Dissolve the Sugar in 20mL water by stirring in the cylinder. Ensure that no sugar particles are left behind.

Step 6. Measure the volume of the colourless sugar solution in the cylinder and note down the reading(V3 mL). Place a white paper behind the measuring cylinder in case if the readings are not visible.

Observations:

1) Weight of Sugar: .....g

2) Volume of water in the measuring cylinder, V1 mL : .....

3) Mark on the measuring cylinder to which water level has risen just after adding solid sugar, V2 mL: .....

4) Volume of the Sugar solution in the measuring cylinder (after dissolving sugar), V3 mL : .....

5) Difference in the volume :(V1-V3) mL Or (V3-V1) mL .....

Conclusion:

A) By dissolving 2 g Sugar in 20 mL water, volume of the resulting solution is .....mL

B) How does the volume of the solution change on dissolution?

_____

Q2. Does the above observation reminds you anything related to your daily life experience?

_____

_____

Q3. If you need to prepare a 100ml solution using water. Which of the following procedures will you follow;

1.Take 100 ml of water in a standard flask and add the required amount of solute. Then, dissolve it.

2. Add the required amount of solute in a standard flask. Add water so that the solute dissolves completely. And make the volume up to the mark of 100ml by adding water.

Task 7: Should we measure Mass or Volume?

A set of measuring equipment are given: dropper, measuring cup, spoon, weighing balance, graduated cylinders. Which one of these will you use to measure the materials given :

Substances	Equipment	Mass (g) or Volume (mL)
Oil		
Water		
Tea powder		
Honey		
Sugar		

Table T1

Q1. Why did you choose the above equipment for different substance?

Q2. Based on your data, can you tell what are the situations where mass measurement is preferred and where volume measurement is preferred?
