# Teacher's Guide

Water

Part 2

Based on the curriculum for Kerala State Board
Standard VIII

JANAAGRAHA CENTRE FOR CITIZENSHIP & DEMOCRACY

Janaagraha's initiative to improve citizen engagement in India's democracy through their civic learning program

Developed in collaboration with Young Leaders for Active Citizenship (YLAC)

**Water| Teacher's Guide (2/3)**
**Part 2**

Class VIII
Board – Kerala State Board
Subject – Science
Textbook – Basic Science Part 2
Chapter 16 – Water
Number of parts – 03
Length – 75-85 minutes (estimated, for a class of 40-45 students)
*Note: Teachers may divide the lesson plan into as many periods as they see fit*

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## Section I – What are we going to learn and why is it important?

### Learning objectives

Students will:

- understand the chemical composition and the chemical properties of water

### Learning outcomes

Students will be able to:

- Identify the chemical components of water by conducting electrolysis of water.
- Differentiate between hard and soft water.
- Explain the reason why water is known as a universal solvent

### Key Terms

| | | | | |
|---|---|---|---|---|
| Hard and Soft water | Electrolysis of water | Polar molecule | Solvent | Hydrogen bond |

### Materials needed

- Images to be shown/drawn.
- Materials for the experiments.

**Section II – How are we going to learn?**

1. Introduction

Time: 15 minutes

Facilitation notes:

| Terms that I know and am sure about | Terms that I do not know about | Terms that I learnt in today's class |
|---|---|---|
| | | |

Classify the following terms as whether you are already sure about it or whether you do not know about it at all. You do not have to define the terms. Do not write anything in the third column. At the end of the class you will writing down the terms you learnt in today's class in the last column.

1. Electrolysis of water
2. Atom
3. Molecule
4. Electron
5. Hard water
6. Soft water
7. Polar molecule
8. Solvent

Take 30 seconds to classify these terms in the first 2 columns.

1. Experiment on Electrolysis of water

Time: 10-15 minutes

Facilitation notes:

- The chemical formula of water is the most popular one. Can you guess what it is? (Take a few responses)
- It is H2O. This means that for every atom of oxygen there are 2 atoms of Hydrogen in one molecule of water.

- We can actually do an experiment where we can test this.

Write the experiment in the format - Objective, Materials required, Steps, Observation and Conclusion on the board (as discussed in the previous lesson). Ask the students to fill this up by themselves after the experiment is conducted. Once they have filled it in, make sure they've covered the points below by sharing it with the entire class.

**Experiment #1**

Objective: To determine the chemical composition of water

Materials Required:

1. 9-V battery
2. a transparent plastic container (small like an ice cream cup)
3. 2 metal notice board pins/thumb pins without plastic
4. Water
5. Baking soda
6. 2 glass test tubes


Steps:

1. Push the 2 pins at the bottom of the cup at the same distance as the 2 terminals on the battery.
2. Fill the cup with enough water to submerge the pins.
3. Dissolve the baking soda in the water
4. Fill the 2 test tubes till the rim with water.
5. Cover the mouths of the test tubes with your thumb and invert them into the container, one over each pin.
6. Place the container on top of the battery, such that the pin heads are placed on top of the 2 terminals of the battery

*Image on the left: Apparatus setup (Source)*

7. After some amount of gases have collected in the test tubes, remove them carefully without letting any air get in by covering it with your thumbs.
8. Get a lit matchstick at the mouth of both the test tubes one after the other. Be careful to keep it away from the face and body.

Note: The test tubes help collect the gases and help observe that quantity of hydrogen is double of oxygen. Even without the test tubes it is possible to conduct the experiment.

Observations


1. Bubbles start appearing from both the pins and they start collecting at the top of the test tubes.
2. One test tube starts filling up faster than the other.
3. When the fire is kept close to the test tube containing more gas, there is a slight pop.
4. When the fire is kept close to the test tube containing less gas, the fire burns brighter

*Image on the left: Electrolysis process (Source)*

Conclusion

Water is composed of hydrogen and oxygen in a 2:1 ratio, making the chemical formula of water $H_2O$.

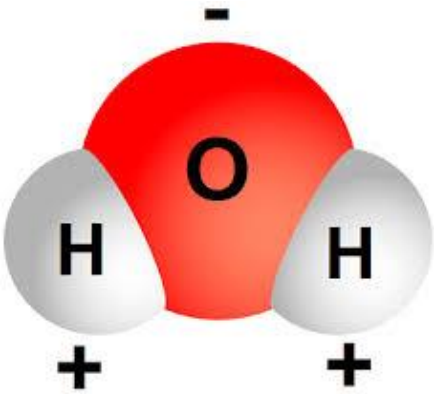
- The decomposition of water into Hydrogen and Oxygen gas due to the passage of electrical current through water is known as electrolysis of water.
- Hydrogen is highly combustible (easily sets on fire), and oxygen aides burning, but it is not flammable by itself. Thus, there is a slight pop when hydrogen burns, and the flame burns brighter when brought close to oxygen.

2. Structure of the water and polarity of water

Time: 10 minutes

Facilitation notes:

- Now that you are aware that every molecule of water contains hydrogen and oxygen, would you be able to draw a typical molecule of water? (Think-pair-share with their partners for 30 seconds and do a diagrammatic representation of a water molecule.)




Source: Socratic

- Oxygen and Hydrogen share their electrons and form a bond. Even though they are sharing their electrons, oxygen has a tendency to pull all the electrons towards itself. This gives the oxygen part of the molecule a partial negative charge and the hydrogen part of the molecule has a slight positive charge.
- We can conduct an experiment to prove this.

(Ask the students to fill the headings in their notebooks by themselves in a similar format once the experiment is conducted)

**Experiment #2**

Objective: To determine the polar nature of the water molecule

Materials required

1. A balloon
2. A Plastic bottle
3. Water

Steps:

1. Make a small hole at the bottom of the plastic bottle such that a thin stream of water can pour from it.
2. Cover the hole with some tape and fill it with water.
3. Fill the balloon with air and tie a knot on it.
4. Rub the balloon on your hair, clothes, etc. to create static electricity.
5. Keep the bottle at a height and open the tape.
6. Bring the balloon close to the stream of water

*(Reference video to demonstrate the experiment)*

Observations

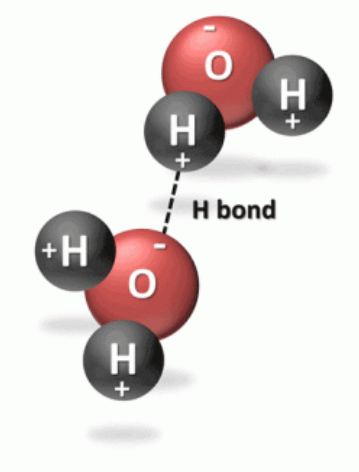
The stream of water moves closer or away from the balloon based on the way the balloon is moved.

Conclusion

We can conclude that the water molecule has a slight positive and negative charge which makes the balloon which is negatively charged to get attracted or repelled from it. This shows that water molecule is polar, which means having opposite electrical charges (positive and negative)

- Because the oxygen has a partial negative charge and the hydrogen has a partial positive charge, the oxygen atom of one molecule gets attracted to the hydrogen of the other water molecule, creating the hydrogen bond. This hydrogen bond is what creates cohesion between the molecules and creates the high surface tension in water. (Reference to previous lesson plan; Image for reference provided below)

- This polar water molecule is also responsible for us to be able to dissolve so many substances in water, as we'll see next.




Source Link

3. Water as a universal solvent

Time: 10 minutes

Facilitation Notes:

- Have any of you seen any substance being dissolved in water? What happened? (Take a few responses)
- Salt, sugar, ink are all examples of substances that can be dissolved in water. But does that mean that everything can be dissolved in water? Are there any examples of substances that can't be dissolved in water? (Take a few responses)
- Let us try an experiment to see if everything can dissolve in water.

**Experiment #3**

Objective: To determine the solvency of water and compare it to the solvency of oil

Materials required

1. 8 transparent containers
2. Water
3. Oil
4. Salt, Sugar, Candle wax and chalk powder

Steps:

1. Fill water in 4 transparent containers and fill oil in 4 other transparent containers
2. Add Salt, sugar, candle wax and chalk powder separately into the 4 different containers with water
3. Repeat the same step for the 4 containers with oil.
4. Stir all the containers.

Observations

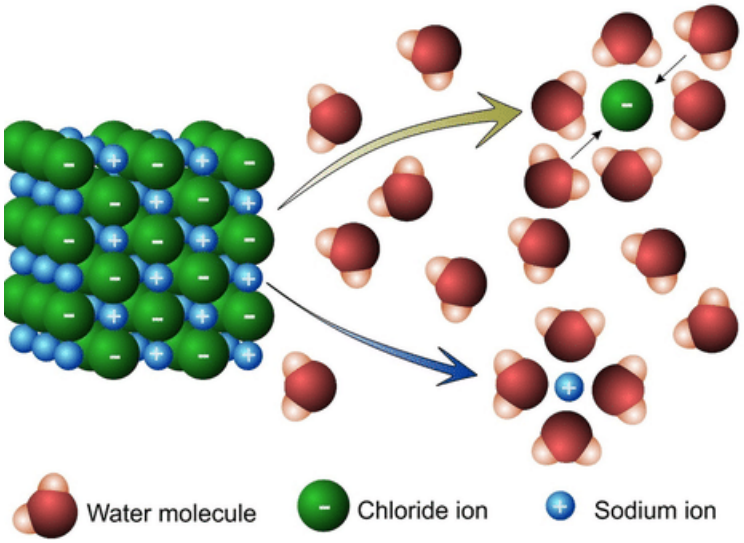
1. Salt and Sugar dissolve in water but not in oil.
2. Candle wax and chalk powder do not dissolve in water or oil.

Conclusion

All substances do not dissolve in water, but water has a higher ability to dissolve substances than oil.

- Water is known as a universal solvent, not because it can dissolve everything, but because it is a liquid that is able to dissolve the highest number of substances.
- The polar nature of the water molecule is responsible for its ability to dissolve so many substances.
- Salt, (Sodium Chloride or NaCl) for example, is made up of Sodium (Na) and Chlorine (Cl). In NaCl, Na has a positive charge whereas Cl has a negative charge because NaCl, like water is polar. The partially positive hydrogen atom in H2O gets attracted to the negative charged Cl and

the partially negative oxygen atom gets attracted to positively charged Na. The water molecules separate Na+ and Cl-, thus dissolving salt in water. (Refer to image below)




- Most polar substances can be dissolved in water. There are some exceptions like chalk powder, as seen in the experiment. Chalk powder is $CaCO_3$ (Calcium Carbonate). The bond that calcium and carbonate share between each other is much higher than its attraction towards the water molecule, because of this calcium and carbonate do not get separated.
- Oil is not polar, because the electrons are equally shared in the atom. When salt is added to oil, no bonds are broken, thus it does not dissolve.
- When some metals react with water, metal hydroxide is formed releasing hydrogen gas. Sodium, potassium and lithium react violently with water by forming its hydroxide and releasing hydrogen gas. Can you try to write the chemical reaction when sodium reacts with water?
- Ans: 2Na + 2H2O ⇨ 2NaOH + H2

- Have you seen iron objects changing colour to orangish brown and becoming rough? What is that? Why does it happen?
- Ans: It is called rust. Iron reacts with water and oxygen to form rust

**Experiment #4**

Objective: To demonstrate that water is a neutral solvent

Materials required:

1. Sodium Hydroxide solution (Sodium hydroxide dissolved in water)
2. Hydrochloric acid solution (Hydrochloric acid dissolved in water)
3. Distilled Water
4. Blue and red litmus paper

Steps:

1. Dip the blue and red litmus papers in distilled water, sodium hydroxide solution and hydrochloric acid solution.
2. Note the observations.

Observations:

1. Red litmus paper turns blue in sodium hydroxide solution
2. Blue litmus paper turns red in hydrochloric acid solution
3. Red litmus paper does not change colour in hydrochloric acid solution
4. Blue litmus paper does not change colour in sodium hydroxide solution
5. Distilled water does not change colour of either blue or red litmus papers

Conclusion:

1. Sodium hydroxide is a base
2. Hydrochloric acid is an acid.
3. Water is neutral – neither an acid or a base.
4. Sodium Hydroxide solution and Hydrochloric acid solution have already been mixed with water and yet they change colour of the litmus paper. Thus, we can conclude that although water by itself is neutral, when mixed with an acid or a base it takes on their properties.

4. Hard and Soft water

Time: 10 minutes

Facilitation Notes:

- Have you ever gone to the beach and tried to use soap in sea water? What happens if you do? Does it lather easily? (Take a few responses)
- This is because the water in the ocean is hard. Hard water means water which has salts of calcium/magnesium dissolved in it. These salts make it difficult for soap to lather. That is why sea water does not lather easily.
- Where do you think these salts came from in the sea? (Take a few responses)
- Likely Responses – Mud, sand, rocks, rivers

**Experiment #5**

Objective: To demonstrate hard and soft water

Materials required:

1. 3 test tubes
2. Calcium Bicarbonate
3. Calcium Chloride
4. Bunsen burner
5. Soap
6. Distilled water

Steps:

1. Fill half of the test tubes with distilled water
2. Dissolve Calcium Bicarbonate in one test tube and Calcium Chloride in another test tube. Keep plain distilled water in the 3rd test tube.
3. Add small pieces of soap to the test tubes and shake it well.

4. Observe the results
5. Boil the solution of water and Calcium bicarbonate and the solution of water with Calcium Chloride.
6. Repeat step 3 with the boiled solution and note the observations.

Observation

1. When soap is added the first time, neither of the solutions with Calcium Bicarbonate and Calcium Chloride lather easily. After shaking it well, there is a murky soap solution with some white substance sticking to the side of the test tube
2. Distilled water lathers well.
3. After boiling the solution with Calcium Bicarbonate lathers well but the solution with Calcium Chloride does not lather well.

Conclusion

1. When Calcium Bicarbonate and Calcium Chloride are dissolved in water, it makes the water hard.
2. Distilled water is soft water because it lathers well.
3. After boiling, the solution containing Calcium Bicarbonate has turned into soft water.
4. After boiling, the solution containing Calcium Chloride does not change

If hard water turns into soft water upon boiling, then it is said to have temporary hardness. Hardness due to calcium/magnesium bicarbonate causes temporary hardness. Calcium/Magnesium chloride causes permanent hardness. Hard water does not lather much with soap, as the soap reacts with the dissolved salts to form insoluble salts. These insoluble salts are what we see sticking to the walls of the test tube.

Apart from hard water and soft water, there is also heavy water which contains Deuterium (an isotope of hydrogen) in the water molecule. Hydrogen atom has one proton in its nucleus and one electron, with no neutrons. Deuterium atom has 1 proton and 1 neutron in its nucleus and one electron spinning around it. Heavy water is used in nuclear reactors.

**Section III –Assessment**

Time: 10 minutes

Materials needed: Blackboard and chalk

Facilitation notes:

1. Water molecule is made up of 2 atoms of oxygen and 1 atom of hydrogen. True/False?
2. Rain water is never hard. True/False? Justify your answer.
3. Water molecule is _____, because hydrogen is partially positive, and oxygen is partially negative.
4. Water is known as a universal solvent because it dissolves everything. True/False?
5. Magnesium Carbonate when dissolved in water makes water permanently hard. True/False?

Answer key

1. False. Water molecule is made up of 2 atoms of hydrogen and one atom at oxygen.
2. True. Rain water is made from the water that has evaporated, so it does not have any salts in it. When rain water falls naturally, it does not have salts in it. But it can pick up other elements in the air as it falls – due to pollution and other dissolved substances in the air. Also, it can pick up minerals like chalk, calcium and magnesium makes its way into the ground. So, it may or may not be hard eventually.
3. Polar
4. False. It is called as a universal solvent because it dissolves the maximum number of substances.
5. False. It causes temporary hardness.

**Section IV – Homework**

1. Conduct electrolysis of water at home. Dissolve common salt in a cup of water. Take 2 pencils and sharpen both the ends of both the pencils. Make 2 holes in a cardboard such that the pencils fit perfectly through it. Make the top end of pencil leads touch the 2 terminals of a 9-v battery. Observe the results. How would be able to find out which pencil has hydrogen gas, and which has oxygen collecting?
2. Check the hardness of the water in your house. Take a little bit of tap water in an empty clean bottle. Add a little bit of soap and shake it hard. Take some boiled and filtered drinking water in another bottle and put some soap in it. Shake it well. Write down the observations and conclusion.

**Section V – Closure**

Time: 5 minutes

**Summary by students**

Get a student to summarise the chemical characteristics of water that were discussed in class by writing their learning in the 3rd column of the table drawn on page 1. Ask different students to share the points one by one with the whole class.

**Recap by a student**

Time: 2 minutes

**Recap by the teacher**

Time: 3 minutes

Please ensure that all the following points are covered in the recap by the teacher and student.

- The chemical characteristics of water were covered. The following points were discussed in detail.
    - The decomposition of water into Hydrogen and Oxygen gas due to the passage of electric current through water is known as electrolysis of water.
    - Water molecule consists of 2 atoms of hydrogen and 1 atom of oxygen. The oxygen atom pulls most of the electrons towards itself which makes the hydrogen atoms partially positive and the oxygen atom partially negative. This makes it a polar molecule.
    - The polarity of water and the hydrogen bond creates the high surface tension on water.
    - The polarity is also responsible for dissolving maximum number of substances in it, which makes water a universal solvent.
    - When carbonates and chlorides of calcium and magnesium is dissolved in water it makes the water hard. Hard water does not easily lather with soap. Carbonates of calcium and magnesium cause temporary hardness which can be removed by boiling the water.

**Section V – Additional Resources**

**Resources for teachers**

1. Video: Reactions of metals with water
   This video explains how different metals in the periodic table reacts with water
   Link: Video

2. Video: Water Electrolysis
   This video explains the experiment on electrolysis of water as given in this lesson plan and an alternate method of conducting the same experiment.
   Link: Video

**Resources for students**

1. Video: How polarity makes water behave strangely
   This TED-Ed video explains the polar nature of water and how that affects the cohesion, adhesion, surface tension, and the lesser dense solid form of water.
   Link: YouTube
2. Video: How water dissolves salt
   This animated video shows how water molecules pull apart the ions of sodium and chloride thus dissolving salt.
   Link: YouTube

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