شرح الماء ومحاليله – الدرس الثالث من الوحدة الأولى



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Water and Its Solutions

my handwritten summary * figures * tables * quizzes

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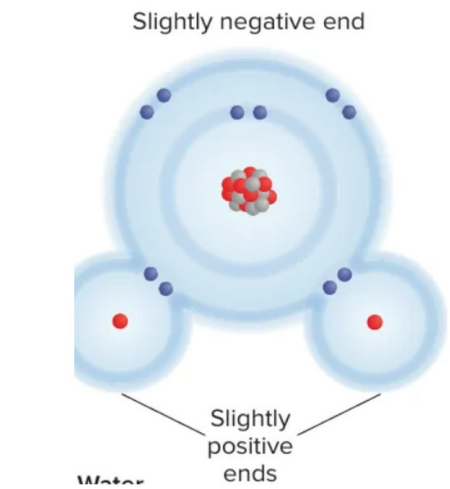


Figure 19 - water is a polar molecule

Key questions

1. Why do many things dissolve in water?
2. What makes water molecules attract?
3. How are acids and bases different?

Inside this notebook

Clear notes, diagrams and comparisons; MCQ section + unit review; complete explained answer key.

Words to master

polarity | van der Waals | hydrogen bond | adhesion | cohesion | solution | solute | solvent | suspension | colloid | acid | base | pH | buffer

(وجعلنا من الماء كل شئ حى)

THE BIG IDEA

Water is polar. Its molecular attractions help explain why it dissolves many substances and supports life.

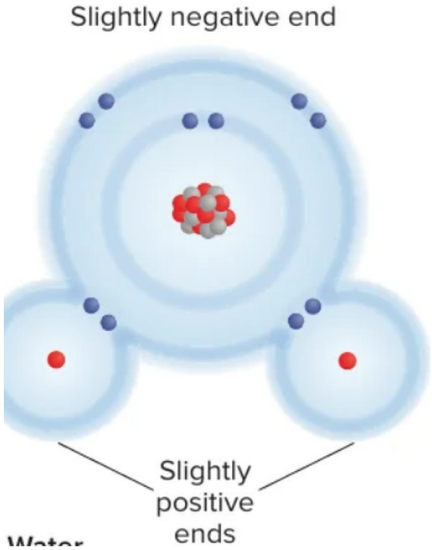
Tiny molecules - enormous effects!

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1. Why is water polar?

Unequal electron sharing

In covalent bonds, atoms share electrons. But they do not always attract electrons equally. In a water molecule, oxygen attracts the shared electrons more strongly than hydrogen.



Textbook Figure 19 - water molecule

Polar molecule

The water molecule has two slightly positive hydrogen ends and one slightly negative oxygen end.

Remember

Polarity means a molecule has two opposite ends, like a tiny magnet.

Follow the charge

Oxygen attracts electrons → **Water** has uneven charge → **Polarity** creates two poles

Why it matters

Polar water molecules attract charged or polar regions of other substances. This helps water dissolve many solutes.

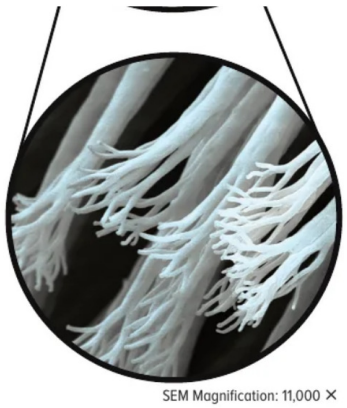
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2. Van der Waals forces

Tiny attractions between molecules

Nearby molecules can attract one another through weak electrostatic forces called van der Waals forces. These are not the strong covalent bonds inside a molecule.



Gecko toe hairs, Figure 20

A gecko on glass!

Countless hairlike structures on a gecko foot produce many small attractions with surfaces. Together, they help the animal climb.



igure 21 Due to the attractive forces between vater molecules, the surface of water supports a vater strider.

Water strider, Figure 21

Water stays together

Attractions between water molecules help form droplets and a surface on which a water strider can stand.

Big comparison

Covalent bonds hold atoms together inside molecules. Van der Waals forces are weaker attractions between nearby molecules.

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3. Hydrogen bonds

Water molecules can attract

The slightly positive hydrogen end of one water molecule is attracted to the slightly negative oxygen end of another. This weak attraction is a hydrogen bond.

Figure 23 Visualizing Hydrogen Bonding

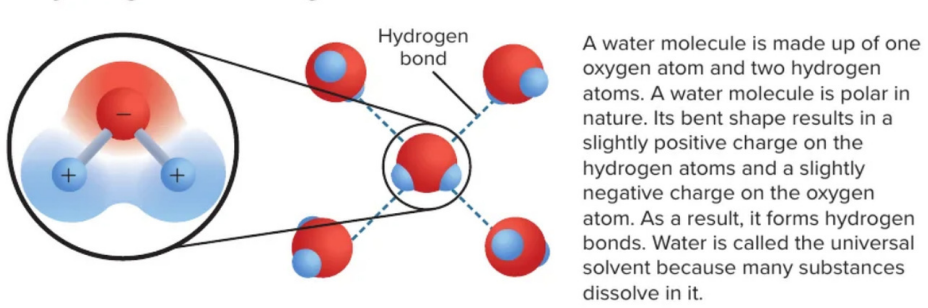


Figure 23 - hydrogen bonding

Inside a molecule

Hydrogen and oxygen atoms are joined by covalent bonds - strong chemical bonds within one water molecule.

Between molecules

Hydrogen bonds are weaker attractions between different water molecules.

Why biology depends on these bonds

- They help water molecules remain together.
- They give water many unusual and life-supporting properties.
- Water changes temperature more slowly than many substances.

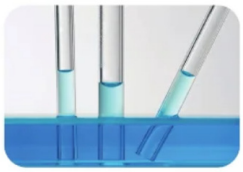
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4. Water has special properties

What hydrogen bonds can do

Figure 23 connects hydrogen bonding with several properties of water that help life survive.



Capillary action in glass tubes



Cups demonstrating adhesion

Adhesion - capillary action



Water strider



Dew on grass

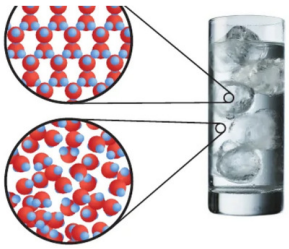
Cohesion - surface tension and dew

Adhesion

Water is attracted to different surfaces. It can climb glass or travel up plant stems.

Cohesion

Water molecules attract each other. This helps form droplets and surface tension.



Ice Floats

Liquid water becomes more dense as it cools to 4°C. Yet, ice is less dense than liquid water. As a result, nutrients in bodies of water mix because of changes in water density during spring and fall. Also, fish can survive in winter because ice floats—they continue to live and function in the water beneath the ice.

Lesson 3 • Water and Its Solutions 1

Ice is less dense than liquid water

Why ice floats

Liquid water becomes most dense near 4 degrees C. Ice is less dense, so it floats, helping life survive under icy water.

Temperature buffer

Water takes a lot of energy to change temperature; it moderates temperature in living things and on Earth.

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5. Mixtures with water

Two or more substances together

A mixture combines substances without producing a new substance. Each part keeps its own characteristics.



A dissolved drink mix in water

Try the drink test

Add powdered drink mix to water and stir. If the particles spread evenly throughout the water, the drink mix becomes a homogeneous solution.

Two mixture types

Homogeneous

Uniform throughout. You cannot tell the different components apart. Example: dissolved drink mix or salt water.

Heterogeneous

Not uniform. Different components can be distinguished. Example: sand in water.

Do not mix it up

Dissolving makes a mixture. It does not automatically create a new substance through a chemical reaction.

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6. Solutes and solvents

The two parts of a solution

A solution is a homogeneous mixture containing a solvent and a solute.

SOLVENT

The substance that dissolves another substance.

SOLUTE

The substance that is dissolved.



Drink mix spreads through water

Example: a drink mix

Water = solvent. Powdered drink mix = solute. The finished drink is a solution because it is uniform throughout.

More solutions in daily life

- Salt water: salt is dissolved in water.
- Saliva: contains water, proteins and salts.
- Air: a solution of gases.

Memory trick

Solvent does the dissolving. Solute gets dissolved.

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7. Suspensions and colloids

Not all mixtures are solutions

Some mixtures are heterogeneous: their components do not spread uniformly. The lesson identifies suspensions and colloids.

Type	What happens?	Example
Solution	Uniform throughout; solute dissolved	Salt water
Suspension	Particles can settle to the bottom	Sand + water
Colloid	Dispersed particles do not settle out	Blood or milk

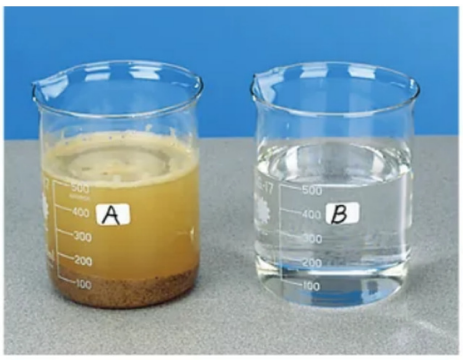


Figure 25 Sand and water form a heterogeneous mixture; you can see both the liquid and the solid. The homogeneous mixture of salt

Sand settles; salt solution stays clear



Figure 26 Blood is a heterogeneous mixture called a colloid.

Blood is described as a colloid

Check your understanding

If the particles sink to the bottom over time, you likely have a suspension. If dispersed particles stay mixed, the mixture may be a colloid.

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8. Acids and bases

What happens in water?

Because water is polar, many substances dissolve in it. Some dissolved substances release hydrogen ions or hydroxide ions.

ACID

Releases hydrogen ions (H+) when dissolved in water. More H+ means a more acidic solution.

BASE

Releases hydroxide ions (OH-) when dissolved in water. More OH- means a more basic solution.

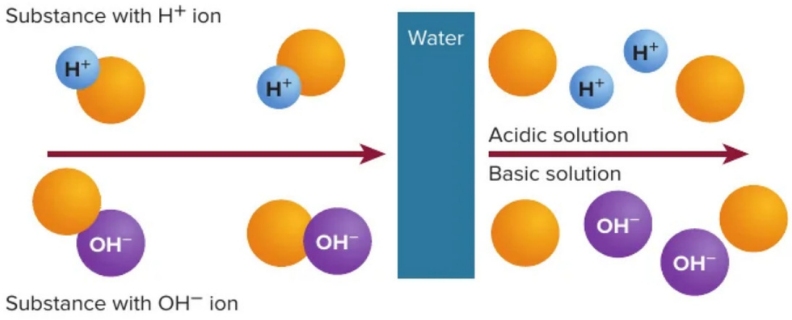


Figure 27 Substances that release H^+ in water are acids. Substances that release OH^- in water are bases.

Textbook Figure 27 - acids release H+, bases release OH-

Everyday examples

Example	What the lesson says
Stomach juices	Highly acidic; they help break down food.
Sodium hydroxide	A base that releases Na+ and OH- in water.

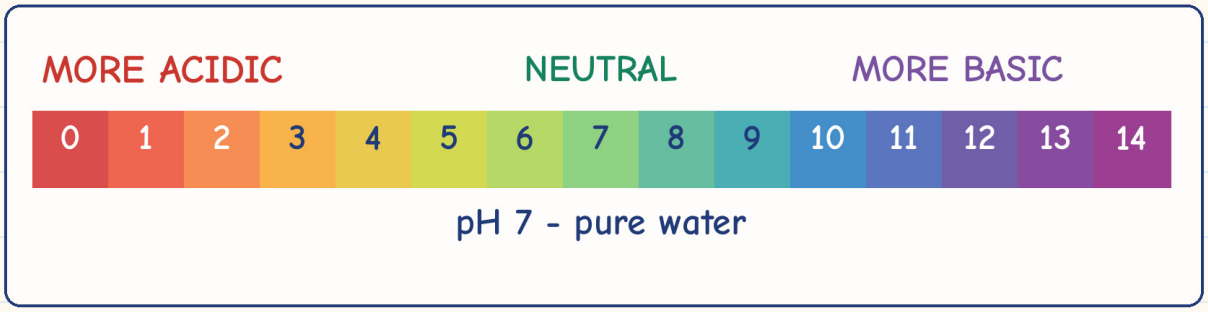
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9. pH and buffers

A scale for acids and bases

pH is a measure of the hydrogen ion concentration in a solution. The scale shown in the lesson ranges from 0 to 14.



Acids: pH below 7

Acids have more H+ ions than OH- ions. Lower pH values indicate more acidity.

Bases: pH above 7

Bases have more OH- ions than H+ ions. Pure water is neutral at pH 7.

Buffers protect cells

Many cellular processes work well between pH 6.5 and 7.5. Buffers are mixtures of weak acids or bases that keep pH in a particular range.

Think like a scientist

Adding hydrochloric acid to water increases H+ concentration and lowers pH. Baking soda, a base, can counter excess H+ in an acidic solution.

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10. Vocabulary corner

Words you should know

Word	Meaning
Polarity	Having opposite ends with unequal charge distribution.
Van der Waals	Weak electrostatic attractions between nearby molecules.
Hydrogen bond	Attraction between oppositely charged regions of molecules.
Adhesion	Attraction between water and other materials.
Cohesion	Attraction between water molecules.
Homogeneous	Uniform composition throughout.
Solution	A homogeneous mixture of solvent and solute.
Solvent	The substance that does the dissolving.
Solute	The substance dissolved in a solvent.
Suspension	Heterogeneous mixture whose particles can settle.
Colloid	Heterogeneous mixture with particles that do not settle.
Acid / base	Releases H+ / releases OH- in water.
pH	Measure of hydrogen ion concentration.
Buffer	Helps keep pH within a particular range.

Big picture

Water polarity -> intermolecular attractions -> unique properties -> many life-supporting roles.

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Section review - multiple choice

Circle the best answer. Check the explanations on the answer-key page.

1 **What makes a water molecule polar?**

A Water contains only one type of atom.

B Its electrons are shared unequally, giving opposite ends.

C The molecule has no electric charge anywhere.

D It is always mixed with salt.

Section review - Q1

2 **Which part of a water molecule is slightly negative?**

A The oxygen end.

B Both hydrogen ends.

C Every atom has exactly the same charge.

D The empty space outside the molecule.

Section review - Q2

3 **Van der Waals forces are best described as...**

A Strong covalent bonds within a molecule.

B A chemical change that creates water.

C Weak attractions between nearby molecules.

D A type of large solid particle.

Section review - Q3

4 **A hydrogen bond in liquid water forms between...**

A Two oxygen atoms in one molecule only.

B Oppositely charged regions of different water molecules.

C Two atoms within the same covalent bond only.

D Only molecules in ice, never liquid water.

Section review - Q4

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Section review (continued)

Circle the best answer. Check the explanations on the answer-key page.

5 **Which observation best illustrates adhesion?**

A Water rises through a narrow glass tube.

B Ice floats in a glass of liquid water.

C Sand sinks to the bottom of a beaker.

D Water molecules form a separate droplet.

Section review - Q5

6 **What does cohesion help explain?**

A Why salt is a strong acid.

B Why sand dissolves instantly.

C Why water is a base.

D Why water molecules gather into droplets.

Section review - Q6

7 **Why does ice float on liquid water?**

A Ice has a higher density than water.

B All water molecules disappear when frozen.

C Ice is less dense than liquid water.

D Ice has no hydrogen bonds.

Section review - Q7

8 **Why can water dissolve many substances?**

A Its molecules are completely nonpolar.

B Its polarity attracts charged or polar regions of solutes.

C Water always reacts chemically with every solute.

D Water contains no intermolecular forces.

Section review - Q8

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Unit review - apply the ideas

Circle the best answer. Check the explanations on the answer-key page.

1 A powdered drink mixes uniformly with water. The mixture is...

A A homogeneous solution.
B A suspension that always settles.
C A new element.
D A mixture with visible separate layers.

2 In a glass of sweetened water, which is the solvent?

A The sugar.
B The glass.
C The water.
D The spoon.

3 The term solute means...

A A substance that keeps pH constant.
B The liquid that does the dissolving.
C A mixture with large settled particles.
D A substance dissolved in a solvent.

4 Sand and water form which type of mixture?

A A completely uniform solution.
B A heterogeneous suspension.
C A single pure compound.
D A gas mixture.

5 Which statement best describes a colloid?

A Its particles always sink rapidly.
B It must be a pure substance.
C Its particles do not settle out.
D It always contains only water.

6 Blood is identified in the lesson as an example of a...

A Solvent only.
B Colloid.
C Pure solid.
D Strong base.

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Unit review (continued)

Circle the best answer. Check the explanations on the answer-key page.

7 When an acid dissolves in water, it releases...

A Hydrogen ions (H+).
B Hydroxide ions (OH-) only.
C Only electrons.
D No ions at all.

8 When a base dissolves in water, it releases...

A Oxygen gas.
B Hydrogen ions (H+).
C Ice crystals.
D Hydroxide ions (OH-).

9 Pure water at pH 7 is classified as...

A Strongly acidic.
B Neutral.
C Strongly basic.
D A suspension.

10 Which is more acidic: a solution at pH 4 or pH 9?

A pH 4.
B pH 9.
C Both have exactly the same acidity.
D pH does not measure acidity.

11 What is the role of a biological buffer?

A To make all solutions strongly acidic.
B To increase temperature quickly.
C To help keep pH within a particular range.
D To turn water into a suspension.

12 If hydrochloric acid is added to water, what is expected?

A H+ decreases and pH rises.
B H+ increases and pH falls.
C Water becomes pure neutral water.
D Hydroxide ions increase and pH rises.

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Answer key

S = Section review U = Unit review

Q	Ans	Why?
S1	B	Uneven electron sharing creates slightly charged regions.
S2	A	Oxygen attracts the shared electrons more strongly.
S3	C	They are weak electrostatic attractions between molecules.
S4	B	A hydrogen bond is attraction between separate water molecules.
S5	A	Adhesion means water sticks to other surfaces.
S6	D	Cohesion is attraction among water molecules.
S7	C	Ice is less dense than liquid water and floats.
S8	B	Water is polar and interacts with many solute particles.
U1	A	A solution is uniform throughout.
U2	C	The solvent dissolves the solute.
U3	D	A solute is the dissolved component of a solution.
U4	B	Sand particles remain distinct and can settle.
U5	C	Colloids are heterogeneous mixtures whose particles stay dispersed.
U6	B	Blood contains dispersed components and is listed as a colloid.
U7	A	Acids increase the concentration of H+ in solution.
U8	D	The lesson defines bases by release of OH- in water.
U9	B	Pure water is neutral, with pH 7.
U10	A	A lower pH indicates a more acidic solution.
U11	C	Buffers resist large changes in pH.
U12	B	Adding an acid raises H+ concentration and lowers pH.

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Well done!

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