مراجعة عامة Solutions المحاليل

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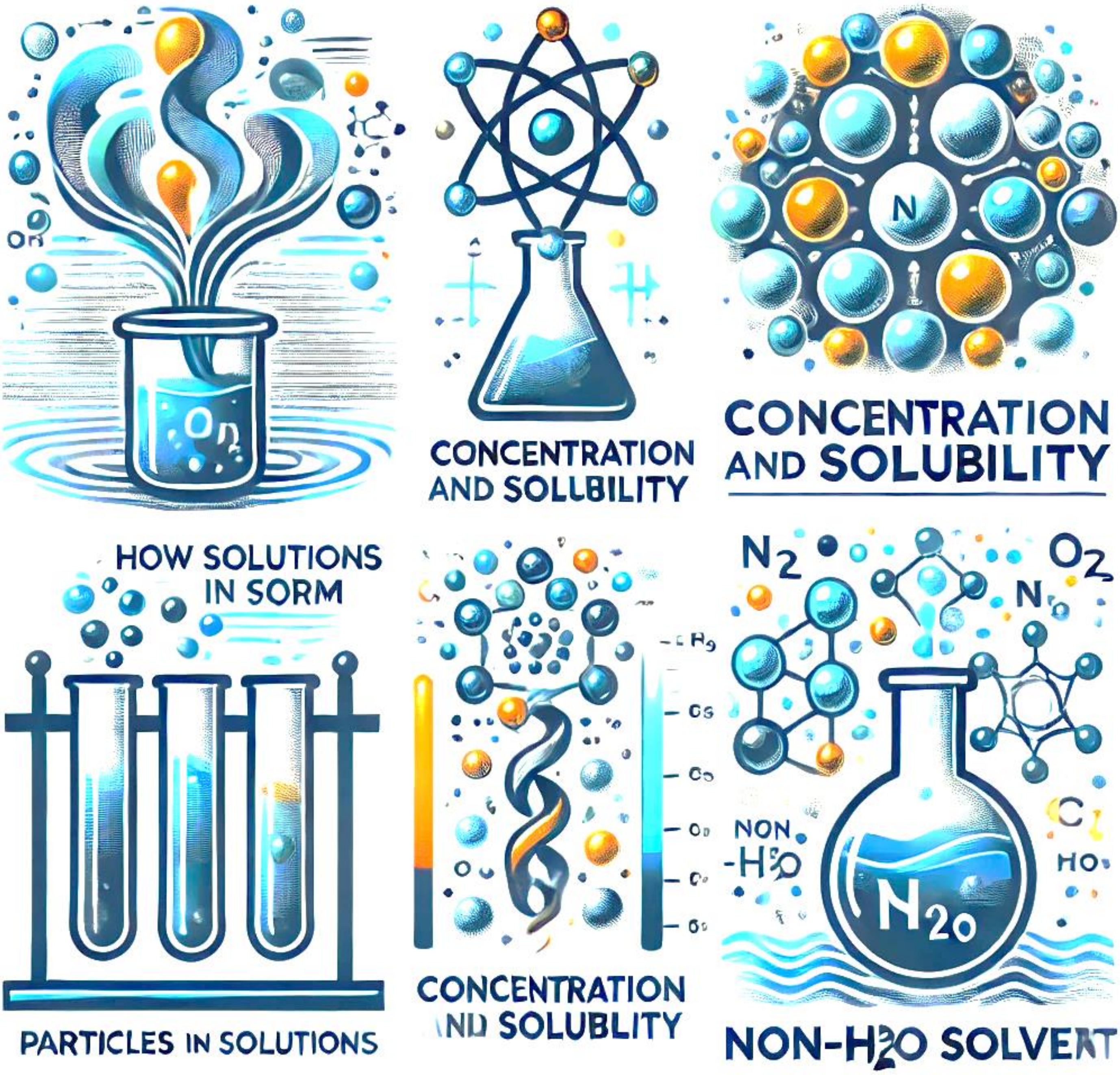

Solutions

physical Science

Worksheets

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هذه الأوراق تستخدم للمراجعة داخل الصف ولا تُغني عن الكتاب المدرسي

HOW SOLUTIONS FORM

What is a Solution?

A solution is a homogeneous mixture composed of two or more substances.

The term "homogeneous" means that the mixture has a uniform composition throughout, so the individual components cannot be distinguished. In a solution:

- **The solute** is the substance that is dissolved (e.g., sugar).
- **The solvent** is the substance that does the dissolving (e.g., water).

How Do Solutions Form?

When sugar is added to water and stirred, the sugar crystals disappear because the sugar molecules separate and spread evenly among the water molecules.

This happens because:

1. **Molecular Interaction**: The sugar molecules interact with the water molecules. Water molecules surround the sugar molecules, breaking the forces that hold the sugar crystals together.
2. **Dissolution Process:** The individual sugar molecules disperse into the water, forming a uniform mixture.

For example, hummingbird food is a liquid solution made by dissolving sugar (solid) into water (liquid). Additionally, gases like oxygen and nitrogen naturally dissolve in water, contributing to the solution's overall composition.

Questions

Section A: True or False

1. (   ) A solution is always made up of two liquids.

2. (   ) Sugar is an example of a solute when mixed with water.

3. (   ) Solutions are heterogeneous mixtures.

4. (   ) Water is commonly used as a solvent in many solutions.

5. (   ) Gases cannot dissolve in liquids to form solutions.

Section B: Matching

Match the terms in Column A with their correct definitions in Column B:

	1. Solvent	C. Substance that dissolves another
	2. Solute	D. Example of a solution
	3. Homogeneous	B. Mixture with uniform composition
	4. Sugar in water	E. Process of forming a solution
	5. Dissolution	A. Substance being dissolved

Section C: Multiple Choice

1. What is the primary characteristic of a solution?

a. It is always a liquid.
b. It has a uniform composition throughout.
c. It is a heterogeneous mixture.
d. It is made only of solids.

2. In the context of solutions, what does the term 'homogeneous' mean?

a. It contains visible particles.
b. The composition is the same throughout.
c. The solute is not completely dissolved.
d. It contains different substances in separate layers.

3. When sugar dissolves in water, which of the following occurs?

a. Sugar molecules chemically react with water.
b. Sugar molecules remain as whole crystals.
c. Sugar molecules are evenly distributed among water molecules.
d. Water molecules break apart into hydrogen and oxygen.

4. Which of the following is NOT an example of a solution?

a. Saltwater
b. Oil and water
c. Sugar water
d. Air

5. What is the role of water in a sugar-water solution?

a. It acts as the solute.

b. It acts as the solvent.

c. It forms new chemical bonds with sugar.

d. It remains separate from the sugar.

6. Which statement about solutes and solvents is true?

a. A solvent is always a liquid.

b. A solute must be a solid.

c. A solution’s solute is dissolved in the solvent.

d. Solutes and solvents must have the same physical state.

7. Hummingbird food is an example of a solution because:

a. The sugar and water form layers.

b. Sugar molecules are uniformly distributed in water.

c. The mixture separates over time.

d. The sugar does not fully dissolve.

8. What determines whether a substance dissolves in a solvent?

a. The size of the solvent molecules

b. The interaction between solute and solvent molecules

c. The color of the solute

d. The temperature of the room

9. Gases like oxygen and nitrogen dissolve in water to form solutions. What type of solution is this?

a. Gas-liquid solution

b. Solid-liquid solution

c. Liquid-liquid solution

d. None of the above

10. Which of the following best describes the dissolution process?

a. Solute molecules are broken into atoms.

b. Solvent molecules are destroyed.

c. Solute molecules spread evenly among solvent molecules.

d. Solvent molecules bond permanently with solute molecules.

Understanding Solutions

Solutions are a fundamental concept in chemistry and everyday life.

A solution is a homogeneous mixture, meaning it has the same composition throughout.

The components of a solution include,

A solute, the substance being dissolved,

A solvent, the substance in which the solute dissolves.

For example, in saltwater, salt is the solute, and water is the solvent.

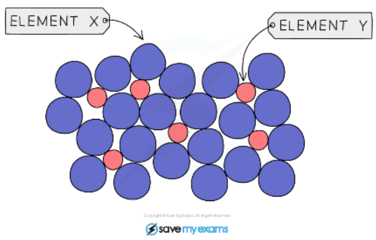
Solutions can exist in various states of matter: solid, liquid, or gas. For instance,
air is a ***gaseous solution*** of oxygen and other gases like nitrogen and carbon dioxide.
Solid solutions, known as alloys, include materials like bronze (a mixture of copper and tin) and brass (a mixture of copper and zinc).
In ***liquid solutions***, the solvent is typically the component present in the larger amount. For example, in sugar water, sugar dissolves evenly in water to form a liquid solution.

The process of forming a solution involves interactions between the particles of the solute and the solvent. In the case of sugar dissolving in water, the water molecules surround the sugar molecules, breaking them apart and distributing them uniformly. This is why the sugar appears to 'disappear.' Solutions are an essential part of many biological, industrial, and environmental processes.

Alloys are Solid solutions created by melting and mixing the solute and solvent metals, then allowing them to solidify.

These solutions often exhibit unique properties, such as enhanced strength or conductivity, making them valuable in manufacturing and technology.

Understanding the composition of solutions is also important in designing materials for specific purposes. For example, the Sacagawea dollar coin was designed using a manganese brass alloy to ensure it had the same size and mass as earlier coins, while also meeting specific electrical conductivity requirements for vending machines.



how vending machines recognize the correct currency, in points:

- Vending machines identify coins by:
  - Size
  - Mass
  - Electrical conductivity
- The **Sacagawea dollar** was introduced in 2000 to replace the Susan **B. Anthony dollar**.
- Both dollars have the same:
  - Size
  - Mass
- <u>They differ in electrical conductivity due to their different metal compositions</u>.
- Electrical conductivity is based on the alloy composition:
  - Each alloy has its own specific conductivity.
- To avoid modifying vending machines:
  - The Sacagawea dollar was made with a specific alloy composition to match the conductivity of the Susan B. Anthony dollar.
- Composition of Sacagawea dollar:
  - Copper core: 50% of the coin's thickness
  - Outer layer (manganese brass alloy):
    - 7% Manganese
    - 4% Nickel
    - 12% Zinc
    - 77% Copper
- Matching the conductivity avoided the expensive task of replacing vending machines.

True or False Questions

1. (   ) A solution is a heterogeneous mixture.

2. (   ) The substance being dissolved in a solution is called the solvent.

3. (   ) Alloys are examples of solid solutions.

4. (   ) In saltwater, water is the solute.

5. (   ) Air is a solution composed primarily of oxygen.

Matching Questions

Match the term with its correct description:

	Term	Description
	A. Solvent	1. A solid solution of metals
	B. Solute	2. The substance that dissolves another
	C. Alloy	3. The substance that is dissolved
	D. Homogeneous mixture	4. A mixture with uniform composition

Multiple Choice Questions

1. What is the solvent in a solution of sugar water?

a) Sugar
b) Water
c) Both sugar and water
d) Neither

2. Which of the following is an example of a gaseous solution?

a) Saltwater
b) Air
c) Bronze
d) Sugar water

3. What term describes a mixture with the same composition throughout?

a) Heterogeneous mixture
b) Homogeneous mixture
c) Colloid
d) Suspension

4. In an alloy of copper and zinc, which term best describes zinc?

a) Solvent
b) Solute
c) Alloy
d) Solution

5. Why do sugar crystals disappear when dissolved in water?

a) They react chemically with water.
b) They disperse evenly among water molecules.
c) They evaporate.
d) They form a heterogeneous mixture.

6. What process is used to create solid solutions like alloys?

a) Dissolving

b) Melting and mixing

c) Evaporating

d) Freezing

7. Which of the following is NOT a characteristic of a solution?

a) Uniform composition

b) Components can be separated by filtration

c) Contains a solute and solvent

d) Can exist in solid, liquid, or gas form

8. What is the main component of air?

a) Oxygen

b) Nitrogen

c) Carbon dioxide

d) Argon

9. What type of solution is bronze?

a) Liquid solution

b) Gaseous solution

c) Solid solution

d) Aqueous solution

10. Which property is important for coins used in vending machines?

a) Color

b) Electrical conductivity

c) Size only

d) Mass only

How Substances Dissolve

Substances dissolve in liquids when the solute (the substance being dissolved) interacts with the solvent (the substance doing the dissolving). This process depends on the nature of the solute, solvent, and the interactions between their particles.

- Dissolving Solids in Liquids:

Water molecules are constantly moving, and water is a polar molecule.

When a solid is added to a liquid, dissolving begins at the solid's surface. Interactions of matter at the bulk scale are determined by electrical forces within and between atoms. For example, when sugar is added to water, water molecules interact with sugar molecules at the surface, breaking them apart and spreading them throughout the liquid. This process can be broken down into three key steps:

1. **Attraction**: Water molecules, which are polar (having positive and negative charges), are attracted to the charged ends of the sugar molecules.
2. **Separation**: The movement of water molecules pulls the sugar molecules away from the solid crystal.
3. **Dispersion**: Sugar molecules spread out evenly among the water molecules, forming a homogeneous mixture.

- Dissolving Gases in Liquids:

Liquid and gas particles move much more freely than particles of solids move. When gases dissolve in gases or when liquids and gases dissolve in liquids, particle movement eventually spreads solutes evenly throughout the solvent, resulting in a homogeneous mixture.

- Dissolving Solids in Solids:

Solid particles move slightly, but not enough to mix evenly. Metals are melted to form a liquid, allowing atoms to spread evenly. Once cooled, the mixture remains uniform.

Questions

Part 1: True or False

1. (   ) Dissolving sugar in water involves breaking the sugar crystal into individual sugar molecules.

2. (   ) Solid solutions, such as alloys, are formed without melting the solids.

3. (   ) Gases dissolve in liquids more effectively at higher pressures.

4. (   ) Water molecules are nonpolar, meaning they have no charges.

5. (   ) Dissolving occurs only at the surface of a solid solute.

Part 2: Matching

Match the terms in Column A with their definitions or examples in Column B.

	Column A	Column B
	Solvent	1. mixture of copper and tin.
	Solute	2. Dissolves other substances.
	Homogeneous mixture	3. Dissolved substance.
	Alloy	4. Water molecules pulling sugar into a solution.
	Dissolution process	5. Uniform composition throughout.

Part 3: Multiple Choice Questions

6. What is the first step in the process of dissolving a solid in a liquid?

a. Dispersion of molecules

b. Attraction between solute and solvent molecules

c. Cooling of the solvent

d. Evaporation of the liquid

7. What type of mixture is formed when a substance dissolves completely in a solvent?

a. Heterogeneous
b. Colloid
c. Suspension
d. Homogeneous

8. Which factor increases the solubility of a gas in a liquid?

a. Decreasing pressure
b. Increasing temperature
c. Increasing pressure
d. Decreasing solvent volume

9. What property of water makes it an effective solvent?

a. It is nonpolar.
b. It has charged ends (polar).
c. It has low density.
d. It is a solid at room temperature.

10. Which of the following is an example of a solid solution?

a. Saltwater
b. Air
c. Bronze
d. Soda

11. What happens during the dispersion stage of dissolving?

a. Solvent molecules evaporate.
b. Solvent molecules attract solute molecules.
c. Solute molecules spread evenly throughout the solvent.
d. Solute molecules solidify.

12. How do gases typically dissolve in liquids?

a. By melting the gas first
b. By forming a suspension
c. By interacting and spreading evenly among liquid molecules
d. By cooling the liquid below freezing

13. Why are alloys melted before forming solid solutions?

a. To ensure uniform mixing of the atoms
b. To increase their density
c. To remove impurities
d. To reduce their solubility

14. What is the primary solvent in carbonated soft drinks?

a. Carbon dioxide
b. Water
c. Sugar
d. Air

15. Which of the following best describes the term "solute"?

a. The substance that dissolves in a solution
b. The substance that dissolves other materials
c. A mixture of solids and gases
d. A type of solvent with polar properties

Rate of Dissolving

The rate at which a solute dissolves in a solvent can be affected by stirring, surface area, and temperature. These factors influence how quickly solute particles are broken apart and distributed in the solvent.

1. Stirring:

When you stir a solution, the solvent molecules move around more, bringing more solvent into contact with the solute. Stirring helps to increase the rate at which the solute dissolves.

Why it works:

- Stirring causes solvent molecules to collide more frequently with solute particles, helping the solute dissolve faster.
- It increases the uniformity of the solution, preventing solute from accumulating in one area.

2. Surface Area:

The surface area refers to the area of the surface of the solute exposed to the solvent. The greater the surface area, the faster the dissolving process. When a solute is broken into smaller pieces, the surface area increases because there is more area for the solvent molecules to interact with the solute particles.

Example 1: Surface Area of a Cube

Consider a cube of salt with dimensions 2 cm x 2 cm x 2 cm. The surface area of a cube is calculated using the formula:

$$\text{Surface Area} = 6 \times (\text{side length})^2$$

$$\text{Surface Area} = 6 \times \text{length} \times \text{width} \qquad \text{(for Cuboid shapes)}$$

For a cube with a side length of 2 cm:

$$\text{Surface Area} = 6 \times (2^2) = 6 \times 4 = 24 cm^2$$

Now, if this cube is cut into 8 smaller cubes (each with a side length of 1 cm), the total surface area increases significantly.

For one smaller cube (side length = 1 cm):

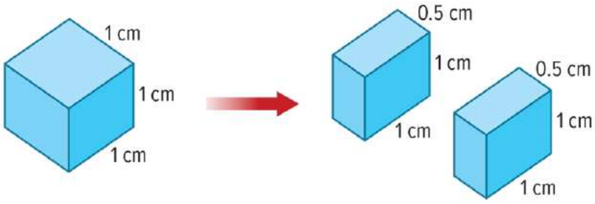
$$\text{Surface Area of one small cube} = 6 \times (1^2) = 6 cm^2$$

Since there are 8 smaller cubes, the total surface area of all the small cubes is:

$$\text{Total Surface Area} = 8 \times 6 = 48 cm^2$$

This demonstrates that cutting the cube increases the surface area, which will allow more solvent to interact with the solute, speeding up the dissolving process.

1) Suppose the length, height, and width of a cube are each 1cm, If the cube is cut in half to form two rectangular pieces,



a) What is the total surface area of the original piece?

b) What is the total surface area of the new pieces?

2) The length, height, and width of a cube are each 3cm If the cube is cut in half to form two rectangular pieces, what is the total surface area of the new pieces?

3) If a cube that has a length, height, and width of 4cm is broken down into 8 cubes of equal size, what is the surface area of the 8 new cubes?

4) A cube of salt with a length, height, and width of 5cm each is attached along a face to another cube of salt with the same dimensions. How much surface area is lost by combining the cubes to form a rectangular solid?

5)

3. Temperature:

Increasing the temperature of the solvent typically increases the rate at which most solutes dissolve. This is because heating the solvent causes the solvent molecules to move faster, which helps them break apart the solute particles more quickly.

Why it works:

- Higher temperatures increase the kinetic energy of the solvent molecules.
- This makes the solvent molecules collide with solute particles more forcefully, speeding up the dissolving process.

Questions

Part 1: True or False

1. ( ) *Stirring a solution moves the solvent and solute particles, speeding up the dissolving process.*
2. ( ) *Increasing the surface area of a solute does not change the rate of dissolving.*
3. ( ) *Heating the solvent generally speeds up the rate of dissolving.*
4. ( ) *Stirring a solution has no impact on the rate of dissolving.*
5. ( ) *The dissolving rate decreases when the surface area of the solute is reduced.*

Part 2: Matching

Match the following factors to their effects on the rate of dissolving:

	Factor	Effect
	Stirring	a. Increases the rate by breaking the solute into smaller pieces.
	Surface Area	b. Increases the rate by moving the solvent around more frequently.
	Temperature	c. Increases the rate by making particles move faster.

Part 3: Multiple Choice Questions

6. What happens when you stir a solution?

a. The solute dissolves slower.

b. The solvent moves around more, bringing more particles into contact.

c. The temperature of the solvent decreases.

d. The surface area of the solute decreases.

7. How does increasing the surface area of a solid affect the dissolving process?

a. It causes the solid to dissolve more slowly.

b. It has no effect.

c. It increases the rate of dissolving.

d. It prevents the solute from dissolving completely.

8. What is the effect of increasing temperature on the rate of dissolving?

a. It slows down the process by reducing particle movement.

b. It has no effect on the process.

c. It increases the rate of dissolving by making the solvent particles move faster.

d. It causes the solute to solidify.

9. Which of the following factors can be combined to speed up the rate of dissolving?

a. Stirring and lowering the temperature.

b. Increasing surface area and lowering the temperature.

c. Stirring, increasing surface area, and increasing temperature.

d. Using a less polar solvent.

10. Why is it important to increase the surface area of a solid solute in dissolving?

a. To decrease the speed at which it dissolves.

b. To allow more solvent particles to come into contact with the solute.

c. To reduce the temperature of the solvent.

d. To decrease the contact between solute and solvent particles.

11. Which of the following will most likely cause a solute to dissolve the fastest?

a. Using a larger solvent.

b. Stirring, heating, and increasing surface area.

c. Using cold water.

d. Reducing the temperature of the solvent.

12. What happens when a solvent is heated?

a. Solvent particles move slower.

b. The solute dissolves at a slower rate.

c. Solvent particles move faster, causing the solute to dissolve faster.

d. The solvent solidifies.

13. If you break a large crystal of sugar into smaller pieces, what happens to the dissolving rate?

a. The dissolving rate decreases.

b. The dissolving rate stays the same.

c. The dissolving rate increases.

d. The sugar will no longer dissolve.

14. How does stirring a solution affect the rate of dissolving?

a. It decreases the rate by slowing down the movement of particles.

b. It speeds up the rate by moving solvent around more efficiently.

c. It has no effect on the rate of dissolving.

d. It makes the solute less soluble.

15. Which factor can be used to control the rate of dissolving?

a. Stirring.

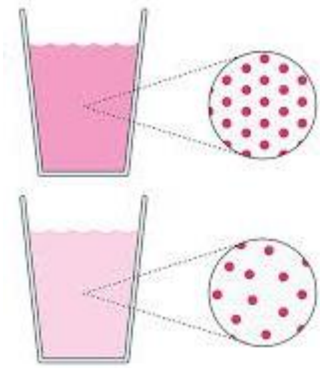
b. Temperature.

c. Surface area.

d. All of the above.

Concentration

When you make lemonade by adding one teaspoon of lemon juice to a glass of water, while your friend adds four teaspoons of lemon juice to another glass with the same amount of water, your lemonade is diluted, and your friend's lemonade is concentrated. A concentrated solution contains a large amount of solute dissolved in the solvent, whereas a dilute solution has a smaller amount of solute in the solvent. These are examples of relative concentrations.



Precise Concentrations

While terms like "**concentrated"** and **"diluted"** provide a general idea of solution concentration, **they are not precise.**

To describe solution concentrations accurately, we use the concentration of a solution, which is the amount of solute dissolved in a given amount of solvent.

One precise way to state concentration is by giving **the percentage by volume** of the solute. For example, if an orange drink has 10% juice by volume, it means that for every 100 mL of the drink, there are 10 mL of juice and 90 mL of water.

Formula for Concentration

The formula for calculating concentration in terms of percentage by volume is:

$$\textbf{Percentage by volume} = \frac{\textbf{Volume of solute}}{\textbf{Volume of solution}} \times 100$$

For example, if you add 20 mL of lemon juice to 80 mL of water, the total volume of the solution is 100 mL. The percentage by volume of lemon juice is:

Volume of solute = 20mL

Volume of solvent = 80mL

Volume of solution = 20mL + 80mL = 100mL

$$\text{Percentage by volume} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$\text{Percentage by volume} = \frac{20\text{mL}}{100mL} \times 100$$

$$\text{Percentage by volume} = 20\%$$

This means that the solution is 20% lemon juice and 80% water.

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If you mix 30 mL of vinegar with 70 mL of water, the total volume of the solution is 100 mL. The percentage by volume of vinegar is:

If you combine 15 mL of orange juice concentrate with 85 mL of water, the total volume of the solution is 100 mL. The percentage by volume of orange juice concentrate is:

Questions

Part 1: True or False

1. (   ) A concentrated solution contains a small amount of solute.

2. (   ) A dilute solution has a large amount of solute.

3. (   ) The concentration of a solution can be expressed as a percentage by volume.

4. (   ) If a solution contains 15 mL of solute and 85 mL of solvent, the percentage by volume of solute is 15%.

5. (   ) Adding more solute to a solution increases its concentration.

Part 2: Matching

Match the following terms to their correct descriptions:

	Term	Description
	Concentrated Solution	1. The substance that is dissolved
	Dilute Solution	2. The substance in which the solute is dissolved
	Percentage by Volume	3. Amount of solute dissolved in a solvent
	Solute	4. Contains a large amount of solute
	Solvent	5. Contains a small amount of solute

Part 3: Multiple Choice Questions

6. What is a characteristic of a concentrated solution?

a. Contains a small amount of solute

b. Contains a large amount of solute

c. Solvent is the main component

d. None of the above

7. How can the concentration of a solution be described precisely?

a. By using terms like "concentrated" and "diluted"

b. By giving the percentage by volume of the solute

c. By the color of the solution

d. By the taste of the solution

8. If a solution contains 25 mL of solute in 75 mL of solvent, what is the percentage by volume of solute?

a. 25%

b. 33.3%

c. 50%

d. 75%

9. What happens to the concentration of a solution if more solute is added?

a. The concentration decreases

b. The concentration increases

c. The concentration remains the same

d. The solution becomes diluted

10. Which of the following is true about a dilute solution?

a. Contains a large amount of solute

b. Contains a small amount of solute

c. The solute concentration is 100%

d. It cannot be concentrated

11. How do you calculate the percentage by volume of a solution?

a. (Volume of solution / Volume of solute) ×100

b. (Volume of solute / Volume of solution) ×100

c. (Volume of solute / Volume of solvent) ×100

d. (Volume of solvent / Volume of solution) ×100

12. What is the percentage by volume if you add 40 mL of solute to 160 mL of water?

a. 20%

b. 25%

c. 33.3%

d. 40%

13. In a solution where 10 mL of solute is added to 90 mL of water, what is the percentage by volume of solute?

a. 10%

b. 11.1%

c. 9%

d. 100%

14. Which statement is true about the solute in a concentrated solution?

a. It is in smaller quantity than in a dilute solution

b. It is in larger quantity than in a dilute solution

c. It cannot be measured

d. It is the solvent

15. If you have a solution with 5% solute by volume, what does this mean?

a. 5 mL of solute in 100 mL of solution

b. 5 mL of solute in 95 mL of solution

c. 50 mL of solute in 100 mL of solution

d. 5 mL of solute in 50 mL of solution

How Much Can Dissolve?

You can stir several teaspoons of sugar into lemonade, and the sugar will dissolve. However, if you continue adding sugar, a point is eventually reached when no more sugar dissolves, and the excess sugar sinks to the bottom of the glass. This indicates how soluble sugar is in water.

Solubility is the maximum amount of a solute that can be dissolved in a given amount of solvent at a given temperature.

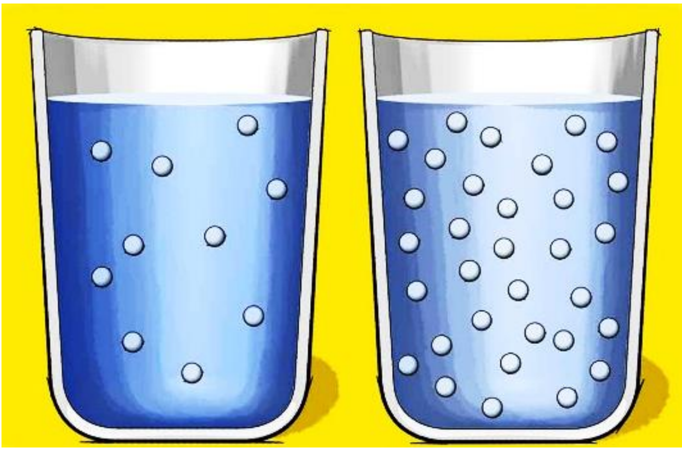
Solubility of substances dissolved in water is often expressed as grams of solute per 100 mL of water (g/100 mL water).

Comparing Solubilities

Imagine two beakers with the same volume of water and two different solutes.

- ✓ In one beaker, one gram of Solute (A) dissolves completely, but additional solute does not dissolve and falls to the bottom of the beaker.
- ✓ In the other beaker, one gram of Solute (B) dissolves completely, and two more grams of Solute (B) also dissolve before additional solute begins to fall to the bottom of the beaker.

Assuming the temperature of the water is the same in both beakers, you can conclude that substance (B) is more soluble in water than substance A.



The solubilities of solutes in water vary. For example, Table 1 shows the solubilities of several substances in water at a temperature of 25°C and normal atmospheric pressure. For solutes that are gases, such as hydrogen, oxygen, and carbon dioxide, the pressure must be given with solubility since solubility can vary at different pressures.

Table 1: Solubility in Water at 25°C and Normal Atmospheric Pressure

State of Substance	Substance	Solubility in g/100 mL of Water
Solid	Salt (sodium chloride)	35.9
	Baking soda (sodium bicarbonate)	9.6
	Washing soda (sodium carbonate)	21.4
	Lye (sodium hydroxide)	109.0
	Table sugar (sucrose)	203.9
Gaseous	Hydrogen	0.00017
	Oxygen	0.005
	Carbon dioxide	0.16

Rank the solubilities of salt, washing soda, and table sugar in water at 25°C from most soluble to least soluble using the information in Table 1.

Questions

Part 1: True or False

1. ( ) *Solubility is the maximum amount of a solute that can be dissolved in a given amount of solvent at any temperature.*
2. ( ) *Temperature does not affect the solubility of a solute.*
3. ( ) *Table sugar is more soluble in water than salt.*
4. ( ) *Washing soda has a higher solubility in water than baking soda.*
5. ( ) *The solubility of gases in water typically decreases as temperature increases.*

Part 2: Matching

Match the following substances to their solubilities in g/100 mL of water:

	Substance	Solubility in g/100 mL of Water
	Salt (sodium chloride)	a. 203.9
	Baking soda (sodium bicarbonate)	b. 35.9
	Washing soda (sodium carbonate)	c. 9.6
	Lye (sodium hydroxide)	d. 109.0
	Table sugar (sucrose)	e. 21.4

Part 3: Multiple Choice Questions

6. What is the solubility of salt in water at 25°C?

a. 9.6 g/100 mL
b. 21.4 g/100 mL
c. 35.9 g/100 mL
d. 109.0 g/100 mL

7. Which substance is the most soluble in water at 25°C?

a. Baking soda
b. Washing soda
c. Lye
d. Table sugar

8. If a solution contains 100 g of table sugar in 100 mL of water at 25°C, is the solution saturated, unsaturated, or supersaturated?

a. Saturated
b. Unsaturated
c. Supersaturated
d. None of the above

9. Which gas has the lowest solubility in water at 25°C and normal atmospheric pressure?

a. Hydrogen
b. Oxygen
c. Carbon dioxide
d. All have the same solubility

10. What happens to the solubility of gases in water as the temperature increases?

a. It increases
b. It decreases
c. It remains the same
d. It varies depending on the gas

11. Which solid has the highest solubility in water at 25°C?

a. Salt
b. Baking soda
c. Washing soda
d. Lye

12. If you have 50 g of lye in 100 mL of water at 25°C, is the solution saturated, unsaturated, or supersaturated?

a. Saturated
b. Unsaturated
c. Supersaturated
d. Cannot be determined

13. Rank the following from most to least soluble in water at 25°C: salt, baking soda, and table sugar.

a. Table sugar > salt > baking soda
b. Salt > table sugar > baking soda
c. Baking soda > salt > table sugar
d. Salt > baking soda > table sugar

14. How is solubility commonly expressed for substances dissolved in water?

a. Grams of solute per liter of solvent
b. Grams of solute per 100 mL of water
c. Milliliters of solute per liter of water
d. Percentage by volume

15. If you add 10 g of baking soda to 100 mL of water at 25°C, will all the baking soda dissolve?

a. Yes
b. No
c. Some will dissolve, and some will not
d. It cannot be determined

Types of Solutions

How much solute can dissolve in a given amount of solvent?

The amount of solute that can dissolve in a given amount of solvent depends on several factors, including the solubility of the solute. Here, we examine three types of solutions based on the amount of solute dissolved in a solvent.

Saturated Solutions

A saturated solution is one that contains all the solute it can hold at a given temperature.

If you add copper(II) sulfate to water and reach a point where no more of the compound dissolves and excess remains at the bottom, you have a saturated solution. Table 2 shows the solubility of several compounds in water at different temperatures.

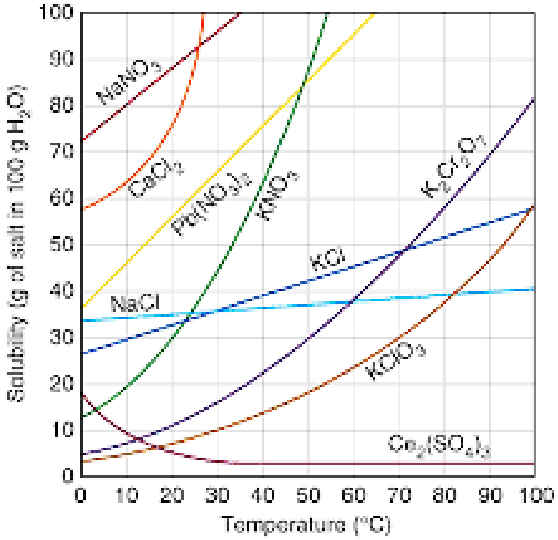
Table 2: Solubility of Compounds in 100 mL of Water at Different Temperatures

Compound	Solubility in g/100 mL of Water at 20°C	Solubility in g/100 mL of Water at 40°C	Solubility in g/100 mL of Water at 100°C
Copper(II) sulfate	23.1	32.0	114
Potassium bromide	53.6	65.3	104
Potassium chloride	28.0	34.0	56.3
Potassium nitrate	13.9	31.6	245
Sodium chlorate	79.6	95.9	204
Sodium chloride	35.7	35.7	39.2
Sucrose (sugar)	179.2	203.9	487.2

Generally, as the temperature of a liquid solvent increases, the amount of solid solute that can dissolve in it also increases.

Explain how the temperature of a liquid solvent affects the solubility of a compound.

As the temperature of a liquid solvent increases, the solubility of most solid solutes increases. This means more solute can dissolve in the solvent at higher temperatures.



Unsaturated Solutions

An unsaturated solution is a solution that can still dissolve more solute at a given temperature.

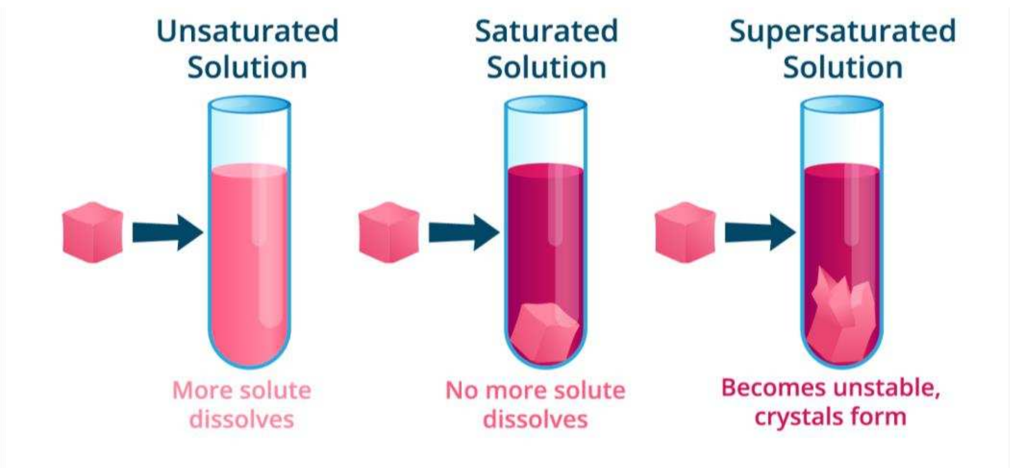
Explain why the term unsaturated is not precise.

The term unsaturated is not precise because it does not specify the exact amount of solute that can still be dissolved in the solvent. It simply indicates that more solute can be added.

Supersaturated Solutions

A supersaturated solution is one that contains more solute than a saturated solution at the same temperature. Supersaturated solutions are unstable and can precipitate the excess solute when disturbed.

For example, if you make a saturated solution of potassium nitrate at 60°C and then let it cool to 20°C, part of the solute comes out of solution because the solvent cannot hold as much solute at the lower temperature. However, if you cool a saturated solution of sodium acetate without disturbing it, no solute comes out of solution, creating a supersaturated solution. Figure 10 shows that when a seed crystal of sodium acetate is added to the supersaturated solution, excess sodium acetate precipitates out.



Explain why supersaturated solutions are unstable.

Supersaturated solutions are unstable because they contain more solute than can be dissolved at the given temperature. Any disturbance, such as adding a seed crystal, can cause the excess solute to precipitate out.

How can the increase of solute be precipitated in supersaturated solution?

Adding a small amount of solute to the solution, it precipitates very quickly aro und the small added part called the seed crestal.

Questions

Part 1: True or False

1. ( ) A saturated solution can hold more solute at a given temperature.
2. ( ) Increasing the temperature of a solvent typically decreases the solubility of a solid solute.
3. ( ) A supersaturated solution contains more solute than a saturated solution at the same temperature.
4. ( ) Unsaturated solutions are unstable.
5. ( ) Table sugar has a higher solubility in water at 100°C than at 20°C.

Part 2: Matching

Match the following types of solutions to their descriptions:

	Type of Solution	Description
	1. Saturated Solution	a. Contains more solute than a saturated solution at the same temperature.
	2. Unsaturated Solution	b. Contains all the solute it can hold at a given temperature.
	3. Supersaturated Solution	c. Can dissolve more solute at a given temperature.

Part 3: Multiple Choice Questions

6. Which of the following is true about a saturated solution?

a. It can dissolve more solute at the same temperature.
b. It contains all the solute it can hold at a given temperature.
c. It is unstable and excess solute precipitates out.
d. It contains less solute than an unsaturated solution.

7. What happens to the solubility of most solid solutes as the temperature of the solvent increases?

a. It decreases.
b. It remains the same.
c. It increases.
d. It varies depending on the solute.

8. If a solution contains 40 g of potassium nitrate in 100 mL of water at 20°C, what type of solution is it?

a. Saturated
b. Unsaturated
c. Supersaturated
d. Cannot be determined

9. Why are supersaturated solutions unstable?

a. They can hold more solute at lower temperatures.

b. They contain less solute than saturated solutions.

c. They contain more solute than can be dissolved at the given temperature.

d. They cannot hold any solute.

10. How does cooling a saturated solution of potassium nitrate affect the solution?

a. It becomes unsaturated.

b. It becomes supersaturated.

c. Part of the solute precipitates out.

d. The solubility of the solute increases.

11. Which compound has the highest solubility in water at 100°C according to Table 2?

a. Potassium bromide

b. Potassium chloride

c. Sucrose (sugar)

d. Sodium chloride

12. If you add 60 g of sodium chloride to 100 mL of water at 25°C, what type of solution do you get?

a. Saturated

b. Unsaturated

c. Supersaturated

d. Cannot be determined

13. What type of solution can still dissolve more solute at a given temperature?

a. Saturated

b. Unsaturated

c. Supersaturated

d. All of the above

14. What is a characteristic of a supersaturated solution?

a. It is stable and can hold more solute indefinitely.

b. It is unstable and can precipitate excess solute when disturbed.

c. It contains the maximum amount of solute that can dissolve at a given temperature.

d. It cannot be created in a laboratory.

15. What happens when a seed crystal is added to a supersaturated solution?

a. It dissolves completely.

b. Excess solute precipitates out of the solution.

c. The solution becomes more stable.

d. No change occurs.

Solution Energy and Solubility of Gases

Solution Energy

The formation of some solutions is ***exothermic***—*they give off energy to the surrounding environment*. One example is reusable heat packs. These heat packs contain a supersaturated solution of sodium acetate. When the solution warms, sodium acetate ions interact with water molecules, releasing heat.

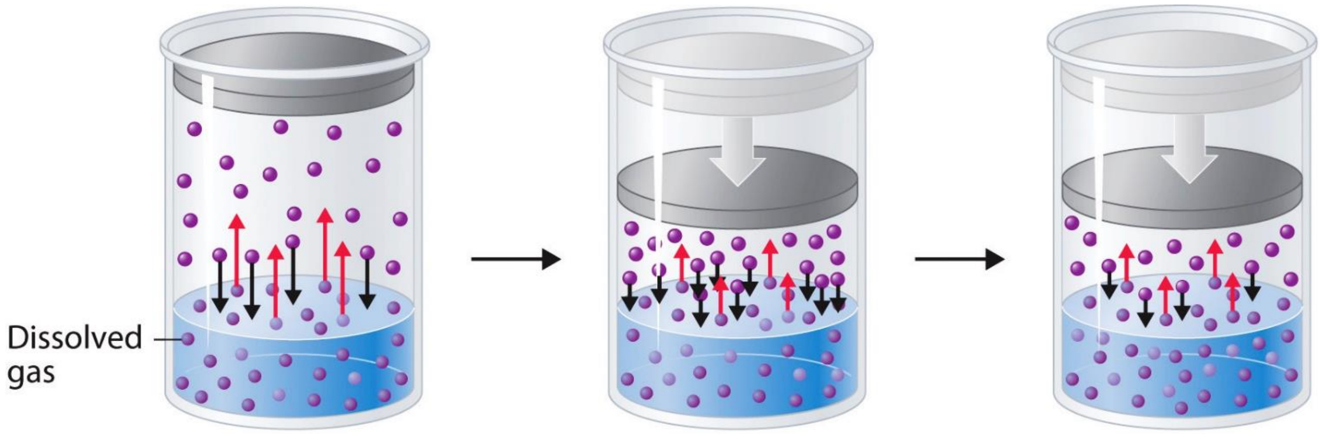
On the other hand, some substances must draw energy from the surroundings to dissolve. During this ***endothermic process***, the solution becomes colder. Cold packs made of ammonium nitrate and water operate in this way. When the inner bag is broken, water mixes with ammonium nitrate. The interaction between ammonium nitrate and water draws energy from the surroundings, causing the pack to cool.

Solubility of Gases

If you shake an opened bottle of a carbonated soft drink, it bubbles up and might squirt out. Shaking, stirring, or pouring a solution of a gas exposes more gas particles to the surface, where they escape from the liquid and come out of solution.

Pressure Effects

Carbonated soft drinks are bottled under pressure to increase the amount of carbon dioxide dissolved in the liquid. When you open the bottle, the pressure inside decreases, and carbon dioxide gas escapes, forming bubbles.



Temperature Effects

To increase the amount of gas dissolved in a liquid, you can cool the liquid. This is the opposite of increasing the solubility of most solids. For example, more carbon dioxide bubbles out of a warm soft drink than out of a cold soft drink.

Questions

Part 1: True or False

1. ( ) The formation of exothermic solutions gives off energy to the surrounding environment.
2. ( ) Cold packs operate using an exothermic process.
3. ( ) Shaking a carbonated drink decreases the amount of gas that escapes.
4. ( ) Carbonated soft drinks are bottled under pressure to keep carbon dioxide in solution.
5. ( ) Cooling a liquid increases the amount of gas that dissolves in it.

Part 2: Matching

Match the following terms to their descriptions:

	Description	Term
	A process where the solution gives off energy and becomes warmer.	Exothermic Process
	Keeping carbon dioxide dissolved in soft drinks by bottling under pressure.	Endothermic Process
	More gas dissolves in a liquid when it is cooled.	Pressure Effects
	A process where the solution absorbs energy and becomes colder.	Temperature Effects

Part 3: Multiple Choice Questions

6. What is an example of an exothermic solution?
   a. Cold packs made of ammonium nitrate
   b. Reusable heat packs
   c. Warm water dissolving salt
   d. Carbonated soft drinks

7. What happens to the temperature of a solution during an endothermic process?
   a. It increases
   b. It decreases
   c. It remains the same
   d. It fluctuates

8. How do carbonated soft drinks keep carbon dioxide dissolved?
   a. By cooling the liquid
   b. By bottling under pressure
   c. By shaking the bottle
   d. By adding more sugar

9. Why does carbon dioxide escape more from a warm soft drink than from a cold one?

a. Because warm temperatures increase solubility of gases

b. Because cold temperatures decrease solubility of gases

c. Because warm temperatures decrease solubility of gases

d. Because cold temperatures increase solubility of gases

10. What happens to the amount of gas dissolved in a liquid when the pressure is decreased?

a. The amount increases

b. The amount decreases

c. The amount remains the same

d. The amount fluctuates

11. Which process is used in cold packs to draw energy from the surroundings?

a. Exothermic process

b. Endothermic process

c. Pressure effects

d. Temperature effects

12. What is the effect of pressure on the solubility of gases in liquids?

a. Increasing pressure decreases solubility

b. Decreasing pressure increases solubility

c. Increasing pressure increases solubility

d. Pressure has no effect

13. Why do carbonated soft drinks bubble out when opened?

a. Because the internal pressure is higher than the external pressure

b. Because the internal pressure is lower than the external pressure

c. Because the temperature inside the bottle is lower

d. Because the sugar content is high

14. What is an example of an endothermic solution?

a. Sodium acetate heat packs

b. Ammonium nitrate cold packs

c. Dissolving sugar in water

d. Shaking a carbonated drink

15. What is the main reason that more carbon dioxide bubbles out of a warm soft drink?

a. Lower pressure inside the bottle

b. Higher solubility of gases in warm liquids

c. Lower solubility of gases in warm liquids

d. Increased shaking of the bottle

Particles in solutions

Charged particles, called ions, are essential for life as they help nerve cells transmit messages and control muscle responses.

Electrolytes are compounds that produce ion-containing solutions in water, which conduct electricity.

Strong electrolytes	weak electrolytes
like sodium chloride	like acetic acid
fully dissociate into ions	partially dissociate
conduct strong currents	conduct weak currents

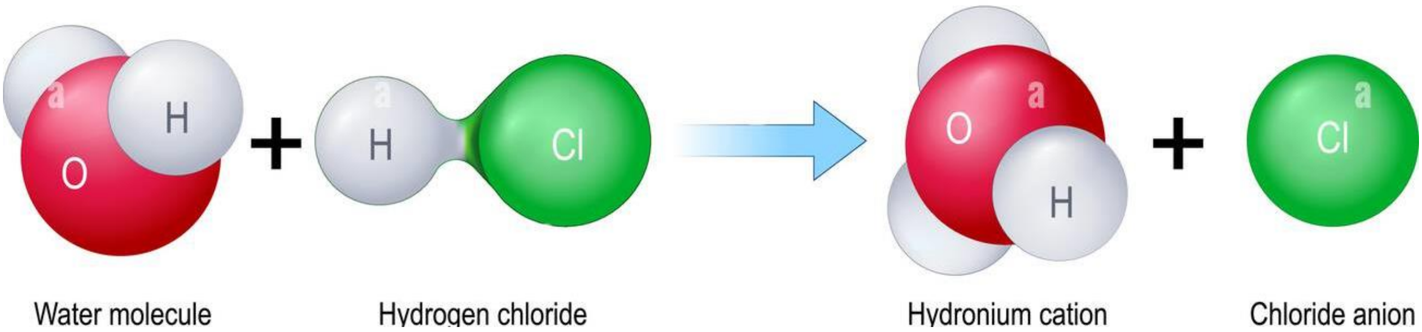
Nonelectrolytes are substances that do not form ions in water, such as fats and sugars, and do not conduct electricity.

Ionization

Ionization is the process by which an atom or a molecule acquires a negative or positive charge by gaining or losing electrons to form ions.

This process can occur in various ways, but let's take a look at hydrogen chloride (HCl) as a model.

When hydrogen chloride (HCl) is dissolved in water, it ionizes to form hydrogen ions (H^+) and chloride ions (Cl^-). The process can be represented as:

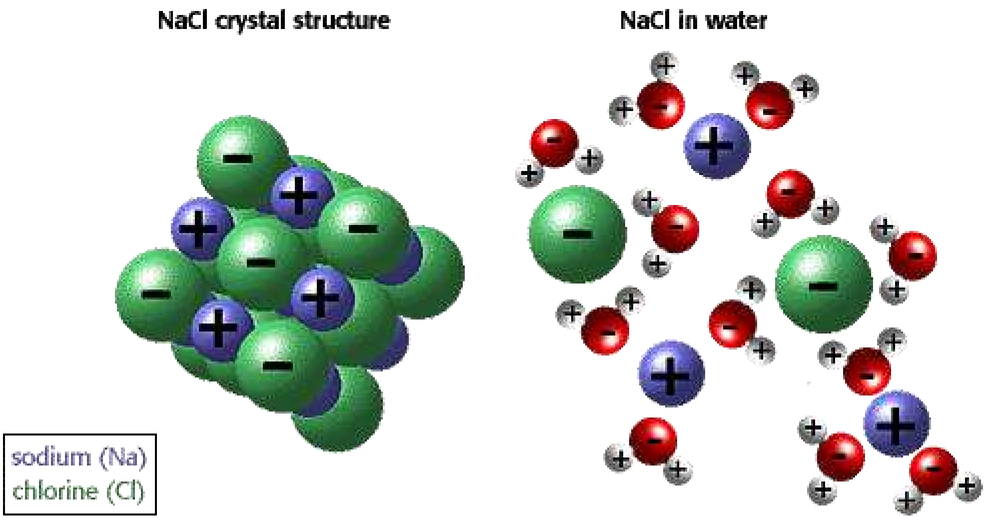


In this process, the HCl molecule is separated into its constituent ions due to the interaction with water molecules.

Dissociation

Dissociation is the process in which positive and negative ions of an ionic solid mix with the solvent to form a solution. The ions already exist in the ionic compound, and polar water molecules surround the ionic compound, pulling it apart into its individual ions.

For example, in a sodium chloride (NaCl) crystal, each positive sodium ion (Na^+) is attracted to six negative chloride ions (Cl^-), and vice versa. When NaCl is placed in water, the polar water molecules break apart the crystalline structure by pulling the ions away and surrounding them in solution. The Na^+ and Cl^- ions have dissociated, and the solution now consists of these ions mixed with water. This solution can conduct an electric current.



Name the two ways that solutions of electrolytes form.

1. Ionization: The process in which a molecular compound forms ions in solution.

2. Dissociation: The process in which an ionic compound separates into its constituent ions in solution.

Compare and Contrast: What are the differences and similarities between dissociation and ionization?

Differences:

- Ionization involves the formation of ions from molecular compounds, which do not contain ions originally.
- Dissociation involves the separation of pre-existing ions in an ionic compound.

Similarities:

- Both processes result in the formation of ions in a solution.
- Both processes enable the solution to conduct electricity.

Questions

Part 1: True or False

1. (   ) Ionization involves the formation of ions from molecular compounds.

2. (   ) Dissociation is the process where molecular compounds form ions.

3. (   ) Sodium chloride dissociates into Na^+ and Cl^- ions in water.

4. (   ) Ionization and dissociation both result in ions in solution.

5. (   ) Water molecules are nonpolar and do not interact with ionic compounds.

Part 2: Matching

Match the following terms to their descriptions:

	c. Forms Na^+ and Cl^- ions in water.	1. Ionization
	e. Break apart ionic compounds and surround ions in solution.	2. Dissociation
	a. Process where molecular compounds form ions in solution.	3. NaCl
	b. Process where ionic compounds separate into ions in solution.	4. HCl
	d. Forms H^+ and Cl^- ions in water.	5. Polar Water Molecules

Part 3: Multiple Choice Questions

6. What occurs during the ionization of hydrogen chloride in water?

a. HCl remains as a molecule

b. HCl forms Na^+ and Cl^- ions

c. HCl forms H^+ and Cl^- ions

d. HCl forms NaCl in water

7. What is the main difference between ionization and dissociation?

a. Ionization involves ionic compounds; dissociation involves molecular compounds

b. Ionization involves molecular compounds; dissociation involves ionic compounds

c. Both involve the separation of pre-existing ions

d. Both result in no ion formation

8. When NaCl is dissolved in water, it dissociates into:

a. NaCl molecules

b. H^+ and Cl^- ions

c. Na^+ and Cl^- ions

d. Na^{2+} and Cl^{2-} ions

9. Which of the following can conduct electricity in a solution?

a. Only ionized compounds

b. Only dissociated compounds

c. Both ionized and dissociated compounds

d. Neither ionized nor dissociated compounds

10. What role do polar water molecules play in dissociation?

a. They do not interact with ionic compounds

b. They surround and pull apart ionic compounds

c. They form new ions in the solution

d. They remain inert and do not influence dissociation

11. What happens to HCl when it is dissolved in water?

a. It forms NaCl

b. It forms H^+ and Cl^- ions

c. It remains unchanged

d. It evaporates

12. How is an ionic compound dissociated in water?

a. By breaking into neutral molecules

b. By forming polar bonds

c. By separating into its constituent ions

d. By reacting with another compound

13. Which of the following statements is true about dissociation?

a. It involves molecular compounds only

b. It results in ion formation in a solution

c. It is the same as ionization

d. It cannot conduct electricity

14. Why do dissociated solutions conduct electric current?

a. They contain free-moving ions

b. They contain neutral molecules

c. They do not contain any particles

d. They are nonpolar

15. What type of solution forms from the dissociation of NaCl in water?

a. Molecular solution

b. Ionic solution

c. Nonpolar solution

d. Covalent solution

Effects of Solute Particles

Effects of Solute Particles on Physical Properties of Solvents

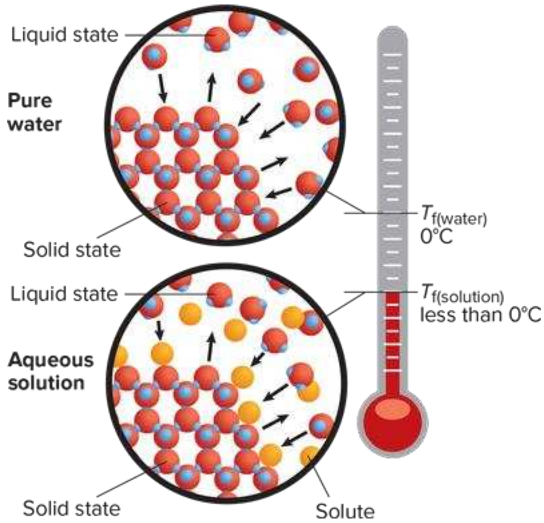
The addition of solute particles to a solvent lead to significant changes in its physical properties, such as freezing and boiling points. These effects are determined by the number of solute particles in the solution (colligative properties) rather than their chemical identity.

1. Lowering Freezing Point (Freezing Point Depression)

How It Works:

In a pure solvent, particles organize into a crystalline solid during freezing. When solute particles are added, they disrupt this orderly arrangement, requiring the temperature to drop further for freezing to occur.

- ✓ The more solute particles present, the greater the disruption and the lower the freezing point.



Real-World Examples:

1. <u>Antifreeze in Cars:</u>
- ✓ Antifreeze (e.g., ethylene glycol) mixed with water in car radiators lowers the freezing point of the fluid, preventing it from freezing in cold climates.
- ✓ For example, a typical mixture of 50% antifreeze and 50% water can reduce the freezing point to about -37°C.

2. <u>Salt in Ice-Cream Makers:</u>
- ✓ Adding salt to an ice-water mixture lowers the freezing point, allowing the mixture to stay liquid at temperatures below 0°C. This speeds up the freezing process of ice cream.

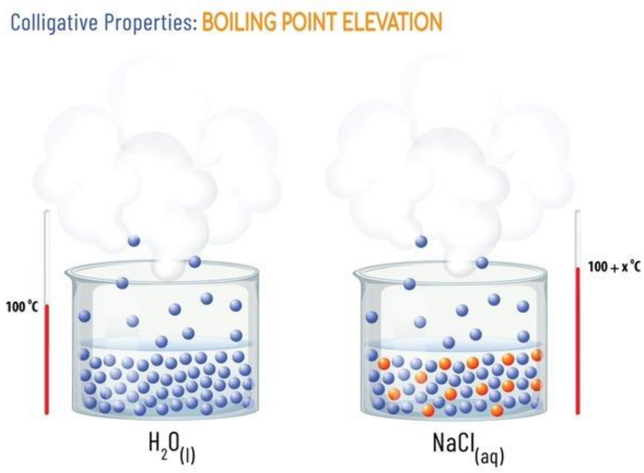
3. <u>Animal Antifreezes:</u>
- ✓ Animals in cold environments produce natural antifreeze substances.
- ✓ **Caribou**: The lower legs of caribou contain substances that prevent freezing in subzero temperatures, allowing them to stand on snow without harm.
- ✓ **Polar Fish**: Fish in polar waters have glycoproteins that prevent the formation of ice crystals in their tissues, ensuring survival in extreme cold.

2. Raising Boiling Point (Boiling Point Elevation)

How It Works:

Adding solute particles lowers the vapor pressure of the solvent. This means that a higher temperature is needed for the solution to reach the boiling point (the point where vapor pressure equals atmospheric pressure).

- ✓ The boiling point increases in proportion to the concentration of solute particles in the solution.



Real-World Examples:

1. <u>Antifreeze in Radiators:</u>

- ✓ Antifreeze not only lowers the freezing point but also raises the boiling point of radiator fluid.
- ✓ This helps prevent overheating in hot weather or during engine operation by allowing the fluid to remain liquid at higher temperatures.

2. <u>Salt in Cooking:</u>

- ✓ While adding salt to water raises its boiling point, the effect is minimal under typical cooking conditions.

Explain how adding a solute affects the freezing point of a solution.

Adding a solute to a solvent lowers the freezing point because the solute particles interfere with the formation of the orderly pattern that the solvent particles need to form a solid. This requires the temperature to decrease further to freeze the solution.

Describe How Antifreeze Affects Vapor Pressure

Antifreeze affects the vapor pressure of a pure solvent by interfering with the solvent particles as they transition from liquid to gas at the surface. This lowers the vapor pressure, meaning that more energy is required for the solvent to escape from the liquid surface, resulting in a higher boiling point.

Questions

Part 1: True or False

1. (   ) Adding antifreeze to water raises the freezing point of the solution.

2. (   ) Solute particles interfere with the solvent particles, lowering the vapor pressure.

3. (   ) The effect of a solute on a solvent depends on the chemical nature of the solute particles.

4. (   ) Solutes can prevent the solvent from forming an orderly solid at its usual freezing point.

5. (   ) Antifreeze helps prevent a car radiator from overheating by raising the boiling point of the fluid.

Part 2: Matching

Match the following terms to their descriptions:

	a. Solute particles interfere with solvent particles transitioning from liquid to gas.	**1. Freezing Point Depression**
	b. Solute lowers the freezing point of the solvent.	**2. Boiling Point Elevation**
	c. A measure of the tendency of molecules to escape from a liquid.	**3. Vapor Pressure**
	d. Prevents freezing and overheating in car radiators.	**4. Antifreeze**
	e. The maximum amount of solute that can dissolve in a solvent.	**5. Solubility**

Part 3: Multiple Choice Questions

6. What is the main effect of adding antifreeze to water in a car radiator?

a. It raises the freezing point of the water

b. It lowers the freezing point of the water

c. It does not affect the freezing point of the water

d. It evaporates immediately

7. How does adding a solute affect the freezing point of a solution?

a. It raises the freezing point

b. It lowers the freezing point

c. It has no effect

d. It varies depending on the solute

8. What happens to the vapor pressure of a solvent when a solute is added?

a. It increases

b. It decreases

c. It remains the same

d. It fluctuates

9. Why does antifreeze raise the boiling point of radiator fluid?

a. It increases the vapor pressure of the solution

b. It decreases the vapor pressure of the solution

c. It changes the chemical nature of the solution

d. It decreases the solubility of the solvent

10. What is the result of adding antifreeze to water in terms of boiling point?

a. The boiling point decreases

b. The boiling point remains the same

c. The boiling point increases

d. The water evaporates immediately

11. How do solute particles affect the freezing process of a solvent?

a. They enhance the formation of an orderly solid

b. They interfere with the formation of an orderly solid

c. They have no effect on freezing

d. They change the chemical nature of the solvent

12. What happens to the amount of energy needed for a solvent to escape from the liquid surface when a solute is added?

a. It decreases

b. It remains the same

c. It increases

d. It fluctuates

13. How does antifreeze prevent a car radiator from freezing?

a. By raising the freezing point of the fluid

b. By lowering the freezing point of the fluid

c. By not affecting the freezing point

d. By increasing the vapor pressure

14. What is the effect of solute particles on the vapor pressure of a solution?

a. They increase the vapor pressure

b. They lower the vapor pressure

c. They have no effect on vapor pressure

d. They change the chemical nature of the solution

15. Why do solutes affect the boiling and freezing points of a solvent?

a. Because they change the solvent's chemical composition

b. Because they interfere with the physical properties of the solvent

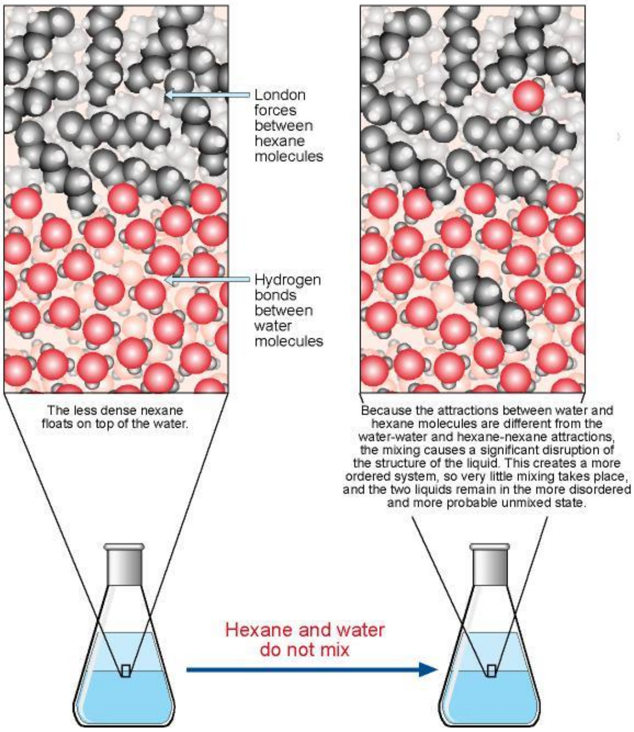
c. Because they increase the vapor pressure of the solvent

d. Because they make the solvent nonpolar

When Water Will Not Work

Nonpolar Solutes

Water is often referred to as the universal solvent because it can dissolve many substances due to



its polar nature. Water molecules have positive and negative areas that allow them to attract polar or ionic solutes. However, nonpolar molecules do not have separated positive and negative areas, making them unable to dissolve in polar solvents like water.

Nonpolar Molecules and Solubility:

Nonpolar molecules, such as oil, do not dissolve in water or dissolve only in very small amounts. Oils contain hydrocarbons, which are large molecules made of carbon and hydrogen atoms. These atoms share electrons almost equally, resulting in nonpolar oil molecules that are not attracted to polar water molecules.

Nonpolar Solvents

Some substances around your house might be useful as nonpolar solvents. For instance:

- **Mineral Oil**: Used to dissolve candle wax from glass or metal candleholders. Both mineral oil and wax are nonpolar substances.
- **Peanut Butter**: Sometimes used to remove bubble gum, another nonpolar substance, from hair.

Oil-based Paints:

Oil-based paints contain pigments dissolved in oil. To thin or remove such paints, a nonpolar solvent must be used. Turpentine, derived from the sap of a pine tree, is a common nonpolar solvent used for this purpose.

Dry Cleaning:

Dry cleaners use nonpolar solvents to remove oil and grease stains without using water. The term "dry" refers to the absence of water in the process. Nonpolar solvents allow nonpolar solute molecules to mix easily, making dry cleaning effective for oil and grease stains.

Drawbacks of Nonpolar Solvents:

Nonpolar solvents have some drawbacks, such as being flammable and potentially toxic. They can be hazardous if they come into contact with skin or if their vapors are inhaled. Proper ventilation is critical because nonpolar solvents tend to evaporate more readily than water, producing high concentrations of harmful vapor in the air.

- Turpentine is a nonpolar solvent that mixes with oil-based paints as a thinner and can be used as a brush cleaner

Questions

Part 1: True or False

1. (   ) Water can dissolve nonpolar molecules easily.

2. (   ) Nonpolar solutes do not dissolve well in water.

3. (   ) Mineral oil is a nonpolar solvent used to dissolve nonpolar substances.

4. (   ) Nonpolar solvents are not flammable.

5. (   ) Dry cleaning uses water to remove oil and grease stains.

Part 2: Matching

Match the following terms to their descriptions:

	a. Contain no separated positive and negative areas.	**1. Polar Solvents**
	b. Cannot dissolve in water or dissolve very little.	**2. Nonpolar Solutes**
	c. Solvents that do not contain water and can dissolve oil-based stains.	**3. Nonpolar Solvents**
	d. A nonpolar solvent used to remove wax.	**4. Mineral Oil**
	e. Used to thin or remove oil-based paints.	**5. Turpentine**

Part 3: Multiple Choice Questions

6. Why do nonpolar molecules not dissolve well in water?

a. Because water is nonpolar

b. Because nonpolar molecules have no separated positive and negative areas

c. Because nonpolar molecules are heavier

d. Because water evaporates quickly

7. What is a common use of mineral oil as a nonpolar solvent?

a. To dissolve polar substances

b. To remove oil-based paint

c. To dissolve candle wax from candleholders

d. To thin water-based paints

8. How do dry cleaners use nonpolar solvents?

a. To remove water stains

b. To remove oil and grease stains

c. To remove sugar stains

d. To remove ink stains

9. What is a drawback of using nonpolar solvents?

a. They are not effective in removing oil stains

b. They are flammable and can be toxic

c. They do not evaporate

d. They are always safe to use in enclosed areas

10. Why is proper ventilation important when using nonpolar solvents?

a. Because they do not produce vapors

b. Because they can produce high concentrations of harmful vapor in the air

c. Because they are non-toxic

d. Because they do not evaporate

11. What kind of molecules do oils contain?

a. Small polar molecules

b. Large nonpolar hydrocarbons

c. Small ionic molecules

d. Large polar molecules

12. What substance is commonly used as a nonpolar solvent to remove oil-based paints?

a. Water

b. Mineral oil

c. Turpentine

d. Alcohol

13. Which of the following is NOT a characteristic of nonpolar solvents?

a. They can dissolve nonpolar substances

b. They are often flammable

c. They are non-toxic and safe

d. They can be hazardous if inhaled

14. Why do dry cleaners use nonpolar solvents instead of water?

a. Because water is not available

b. Because nonpolar solvents can remove oil and grease stains better

c. Because nonpolar solvents are cheaper

d. Because water is harmful

15. What is a common feature of nonpolar molecules?

a. They have separated positive and negative areas

b. They do not have separated positive and negative areas

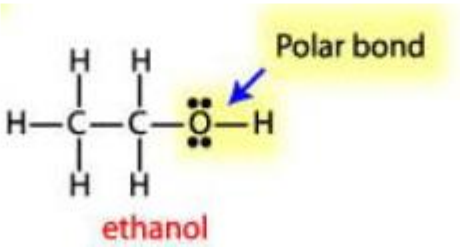
c. They are always ionic

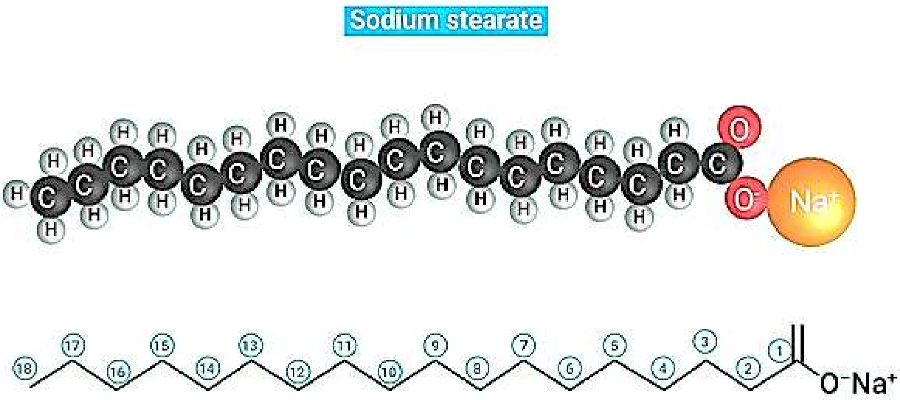
d. They are polar

Versatile Molecules and How Soap Works

Versatile Molecules

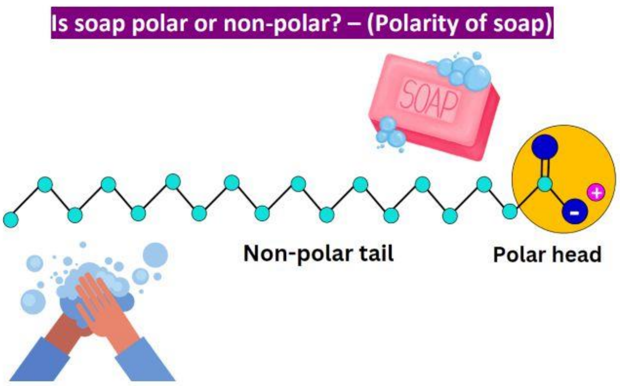
- Some substances have both a nonpolar end and a polar end, making them versatile. For instance, ethanol and sodium stearate have both polar and nonpolar ends.
- These substances can dissolve both polar and nonpolar compounds. Sodium stearate, an important ingredient in soap, has a long nonpolar hydrocarbon chain and an ionic end.

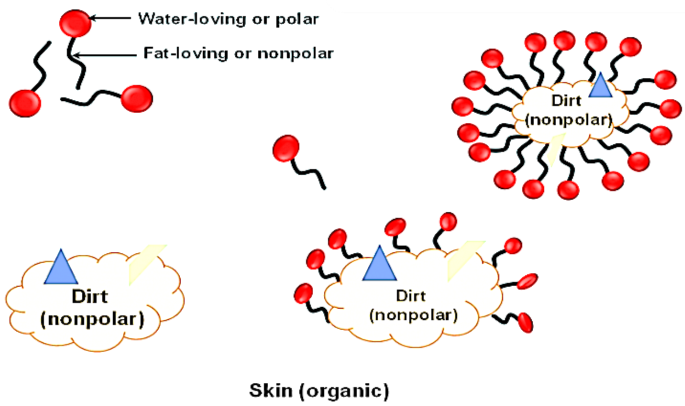




How Soap Works

- **The oils on human skin** and hair help to keep them moisturized but can also attract and hold dirt, which is nonpolar.
- **Washing with water** alone cannot remove oily dirt because it is nonpolar.
- **Soaps** have both polar and nonpolar properties, allowing them to clean oily dirt.
- **Soaps** are salts of fatty acids, which are long hydrocarbon molecules with a nonpolar end and a carboxylic acid group at the other end.
- When soap is made, the hydrogen atom of the acid group is removed, leaving a negative charge that forms an ionic bond with a positive ion of sodium or potassium.
- The ionic end of soap dissolves in water, and the long nonpolar hydrocarbon portion dissolves in oily dirt, allowing the dirt to be washed away.





Questions

True or False:

1. (   ) Turpentine is a polar solvent.
2. (   ) Ethanol has both polar and nonpolar ends.
3. (   ) Sodium stearate is only a nonpolar molecule.
4. (   ) Washing with water alone can remove oily dirt from the skin.
5. (   ) Soaps have both polar and nonpolar properties.
6. (   ) Fatty acids in soaps have a carboxylic acid group at one end.
7. (   ) The ionic end of soap does not interact with water.
8. (   ) Nonpolar substances dissolve well in water.
9. (   ) Sodium stearate is an important ingredient in soap.
10. (   ) Soaps are salts of fatty acids.

Matching:

	a. Versatile molecules	1. Turpentine
	b. Nonpolar solvent	2. Ethanol
	c. Long hydrocarbon chain	3. Sodium stearate
	d. Carboxylic acid group	4. Fatty acids
	e. Dissolves in water	5. Ionic end
	f. Dissolves in oily dirt	6. Nonpolar end

Multiple Choice:

1. Which of the following is a nonpolar solvent?

a) Water　　b) Ethanol

c) Turpentine　　d) Sodium stearate

2. Ethanol is an example of a molecule that has:

a) Only a polar end　　b) Only a nonpolar end

c) Both polar and nonpolar ends　　d) Neither polar nor nonpolar ends

3. Sodium stearate has a:

a) Polar end only
b) Nonpolar end only
c) Both polar and nonpolar ends
d) Neither polar nor nonpolar ends

4. Why is soap required to clean oily dirt?

a) Water alone can clean oily dirt.
b) Soap has polar properties only.
c) Soap has both polar and nonpolar properties.
d) Soap has nonpolar properties only.

5. Soaps are salts of:

a) Alcohols
b) Fatty acids
c) Turpentine
d) Ethanol

6. The ionic end of soap:

a) Dissolves in oily dirt
b) Does not interact with water
c) Dissolves in water
d) Is nonpolar

7. The long nonpolar hydrocarbon portion of soap:

a) Dissolves in water
b) Dissolves in oily dirt
c) Does not interact with oily dirt
d) Is polar

8. Fatty acids in soaps have:

a) An ionic end at both ends
b) A carboxylic acid group at one end
c) Only nonpolar ends
d) Only polar ends

9. What is the role of sodium in sodium stearate?

a) It forms a nonpolar bond
b) It forms an ionic bond
c) It does not interact with the fatty acid
d) It replaces the hydrogen atom of the acid group

10. Which property of soap allows it to carry oily dirt away in water?

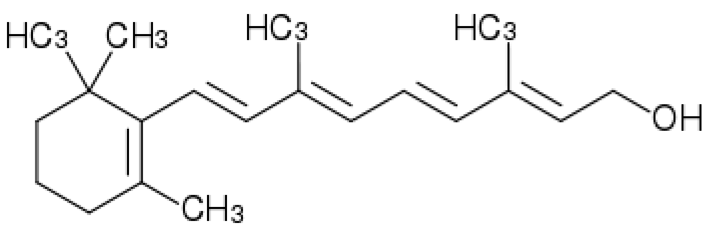
a) Its ability to form a gel
b) Its polar property only
c) Its nonpolar property only
d) Its dual polar and nonpolar properties

Polarity and Vitamins

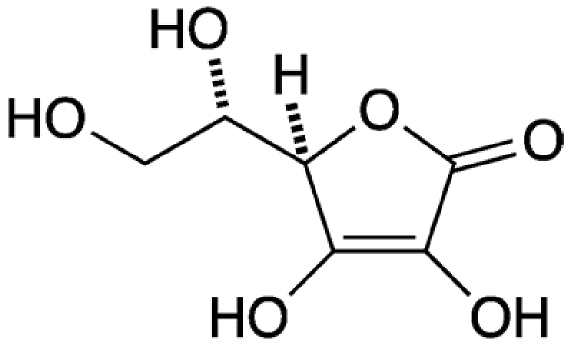
Vitamins play a crucial role in maintaining your health, and taking the right types in correct doses is essential. Here's a detailed explanation and related worksheet:

Polarity of Vitamins:

- Vitamins can be either fat-soluble or water-soluble.
- Fat-soluble vitamins (e.g., Vitamins A, D, E, and K) are nonpolar and dissolve in fat. These vitamins can accumulate in the body's tissues and may become toxic in high concentrations if not taken in the recommended doses.
  - **Vitamin A** has a long hydrocarbon chain, making it nonpolar. It is found in foods such as liver, lettuce, cheese, eggs, carrots, sweet potatoes, and milk (Figure 21).



Vitamin A



Vitamin C

- Water-soluble vitamins (e.g., Vitamins B and C) are polar and dissolve in water.
  - **Vitamin C** has several oxygen-to-hydrogen bonds that make it polar, despite having carbon-to-carbon bonds (Figure 22). It helps heal wounds and aids in the body's absorption of iron.

Importance of Replacing Water-Soluble Vitamins:

- Water-soluble vitamins dissolve in the water present in your body and do not accumulate in tissues because any excess is washed away.
- Hence, it is necessary to replace water-soluble vitamins more quickly by consuming foods that contain them or by taking supplements.

Sources of Vitamin C:

- Various foods are good sources of vitamin C, such as orange juice, green peppers, broccoli, cantaloupe, and strawberries.

True or False:

1. (   ) Vitamin A is polar and dissolves in water.
2. (   ) (   ) Fat-soluble vitamins can accumulate in body tissues.
3. (   ) Vitamin C is nonpolar because it has carbon-to-carbon bonds.
4. (   ) Excess fat-soluble vitamins can be toxic.
5. (   ) Water-soluble vitamins need to be replaced more quickly than fat-soluble vitamins.
6. (   ) Vitamin E is a water-soluble vitamin.
7. (   ) Polar vitamins dissolve in the body's water.
8. (   ) Fat-soluble vitamins wash away with the water present in the cells.
9. (   ) Vitamin C helps heal wounds and absorb iron.
10. (   ) Carrots are a good source of vitamin A.

Matching:

	a. Water-soluble	**1. Vitamin A**
	b. Nonpolar	**2. Vitamin C**
	c. Polar	**3. Fat-soluble vitamins**
	d. Carrots, sweet potatoes, eggs	**4. Foods rich in vitamin A**
	e. orange juice, strawberries, broccoli	**5. Sources of vitamin C**

Multiple Choice:

1. *Fat-soluble vitamins dissolve in:*

a) Water
b) Fat
c) Alcohol
d) None of the above

2. *Vitamin A is found in:*

a) Strawberries
b) Green peppers
c) Lettuce
d) Broccoli

3. *Which of the following vitamins is water-soluble?*

a) Vitamin A
b) Vitamin D
c) Vitamin K
d) Vitamin B

4. Polar vitamins:

a) Accumulate in body tissues

b) Do not accumulate in tissues and are washed away

c) Are toxic in high concentrations

d) None of the above

5. Vitamin C is important for:

a) Bone health

b) Wound healing and iron absorption

c) Vision

d) Blood clotting

6. Excess fat-soluble vitamins can be:

a) Washed away easily

b) Stored in the body's fat tissues and become toxic

c) Harmless

d) All of the above

7. The structural formula of vitamin A shows:

a) Several oxygen-to-hydrogen bonds

b) A long hydrocarbon chain

c) A water-soluble molecule

d) None of the above

8. Foods rich in vitamin C help:

a) Maintain skin health

b) Improve digestion

c) Heal wounds and absorb iron

d) All of the above

9. Which type of vitamin must be replaced more frequently?

a) Fat-soluble vitamins

b) Water-soluble vitamins

c) Both need to be replaced equally

d) Neither, as they are stored in the body

10. Vitamin C has polar groups because it contains:

a) Carbon-to-carbon bonds

b) Hydrogen-to-hydrogen bonds

c) Oxygen-to-hydrogen bonds

d) None of the above