Integrated Sciences

1 sec

First secondary grade

2024 - 2025

Integrated sciences

First secondary
Prepared by experts of science

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Introduction

Planet Earth faces many challenges that threaten the sustainability of life on the planet, and these threats are compounded by intensified humanization and environmental changes, including violent environmental degradation, as well as a growing number of violent extremist groups, according to two criteria. Biodiversity, environmental pollution, depletion of natural resources, urbanization, and expansion. The food security turmoil in the Middle East and North Africa is a common global movement. It includes implementing sustainable environmental policies, reducing greenhouse gas emissions, and protecting the environment. Technologies that preserve the planet's integrity and livability and the role of technology in this regard. To this end and for days through the employment of a wonderful study in the field of computer science and. The different sciences are working together to think and create solutions that will help them reach their goals. This curriculum was conceived in response to the growing need to educate students so that they can work in the field of education. Where he concentrates on a different type of food. the earth and space so that students can see the full picture of the world and fully understand of how factors work, recognizing that natural and technological phenomena are not separate from each other, and the need for a comprehensive understanding of how factors work. This curriculum is based on a philosophy of education that aims to build a deep and comprehensive understanding of How to use scientific knowledge to solve the real issues and challenges facing the world. The curriculum aims to present science as an integrated body of knowledge that supports the advancement of science. In each term, the concepts of physics and chemistry, life, earth and space are integrated, and this is the basis of the program. It prepares students to apply scientific knowledge in a variety of contexts and prepares them to face the challenges of today's world. Hands-on activities are at the core of this approach; they provide students with the opportunity to participate in a variety of activities, such as the following Hands-on, hands-on activities that enhance their understanding and increase their problem-solving skills. This activity also encourages critical thinking and inclusive work, which helps the students to improve their skills in solving problems. The curriculum is encouraged to be based on the premise that students should be at the center of the educational process and that they should participate in the educational process, and that they should participate in the educational process, and. These projects provide students with the opportunity to apply their learning in real-life situations, which enhances the learning of the students in the field of education and promotes the development of their skills in the field of education. It also incentivizes students to attend college in the future. In conclusion, we hope that this program will achieve its goals of building a generation of students.

Authors

General Objectives of the Integrated Science Curriculum

1.Deepen understanding of scientific phenomena:
The curriculum aims to enhance students' understanding of scientific phenomena in an integrated manner, allowing them to see the connections between different branches of science and apply this knowledge in solving life issues.

2.Develop critical and analytical thinking skills:
The curriculum seeks to develop students' critical thinking and analytical skills through interwoven lessons that link physics, chemistry, and life sciences, helping them to analyze scientific phenomena and issues from multiple angles.

3.Promote experiential learning:
The curriculum aims to encourage students to perform practical activities and scientific experiments to deepen their understanding and apply what they have learnt in real situations, thus enhancing their practical skills.

4.Encourage innovation and exploration:
The curriculum seeks to foster students' curiosity and encourage them to explore scientific concepts in new and innovative ways, with a focus on the practical application of technology in solving environmental and energy issues.

5.Promoting Collaboration and Teamwork:
The curriculum aims to develop students' collaboration and teamwork skills through group activities and final projects, enhancing their ability to work effectively in interdisciplinary teams.

6.Apply science to solve global problems:
The curriculum seeks to prepare students to be able to use their scientific knowledge to address global challenges such as climate change, biodiversity conservation, and the development of sustainable energy sources.

7.Building environmental awareness and social responsibility:
The curriculum aims to build students' awareness of environmental issues and challenges facing global societies, while encouraging them to take responsibility for their role in preserving the environment and contributing to the development of sustainable solutions.

Contents

The first term: Sustaining life in ecosystems from the view of scientific integration

First term

Sustaining life in ecosystems from the view of scientific integration

Chapter one: Aquatic ecosystem
Chapter Two: Atmosphere
Chapter Three: The soil
Chapter Four: The role of science in environmental sustainability

Chapter one : Aquatic ecosystem

LEARNING OUTCOMES:

After completing this chapter, the student will be able to:

1. **Recognize the hydrosphere and its relationship with other atmospheres on Earth.**
2. **Explain the role of the water cycle in nature in causing various environmental changes.**
3. **Explain the chemical reactions in the aquatic ecosystem and their effect on water quality and the sustainability of marine life.**
4. **Explain the effect of the physical properties of water such as specific heat, and other physical factors such as temperature and pressure on the distribution of organisms and the sustainability of the aquatic ecosystem.**
5. **Evaluate the biological adaptations of organisms in the aquatic environment and their role in the sustainability of the ecosystem.**

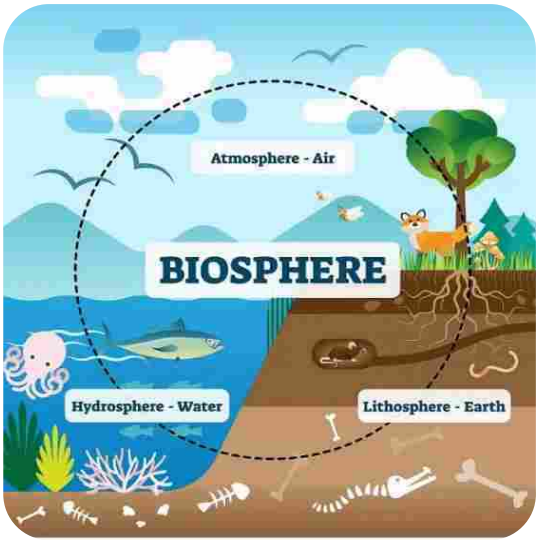
ISSUES INVOLVED

1. **Water pollution**
2. **Climate change**
3. **Sustainability of water resources**
4. **Biological diversity conservation**
5. **Water resources management**
6. **Sustainability challenges in the face of population growth.**

1-1 Chemical reactions and their impact on water quality

Get ready

Have you ever thought when you drink a glass of water, about the chemical reactions that may occur within this vital liquid?
Water is not just a transparent liquid; it is a medium in which many chemical compounds may react, affecting the quality of water and the health of living organisms that depend on it. In this chapter, we will learn about the hydrosphere and the water cycle in nature, as well as some of the basic physical properties and chemical reactions that occur in water, and how these properties and reactions can affect the components of the environment.



Learn

Water has unique properties that support life. Water can dissolve many chemicals and can exist in all three states of matter - solid, liquid, and gaseous states - within the range of known temperatures on the Earth's surface. Water is essential to the continuation of life on Earth. All living cells have a membrane that separates the organism from its environment. Water passes from the environment to the inside of the living cell through this membrane, carrying the substances needed to produce energy, as well as eliminating waste products to the outside.

◆ The hydrosphere on Earth:

The hydrosphere distinguishes Earth from other planets in the solar system. About 70% of the Earth's surface is covered by water (Figure 1). About 97% of this water is found in the oceans, seas, and salt lakes as salt water. The fresh water and is found in rivers, freshwater lakes and groundwater represents approximately 1%. And the reminder part represents the frozen water in polar regions, mountain peaks and glaciers.
Egypt is characterized by its diverse aquatic environments, which include the Nile River, the Gulf of Suez, the Gulf of Aqaba, the Red Sea, the Mediterranean Sea, and many salt and freshwater lakes.

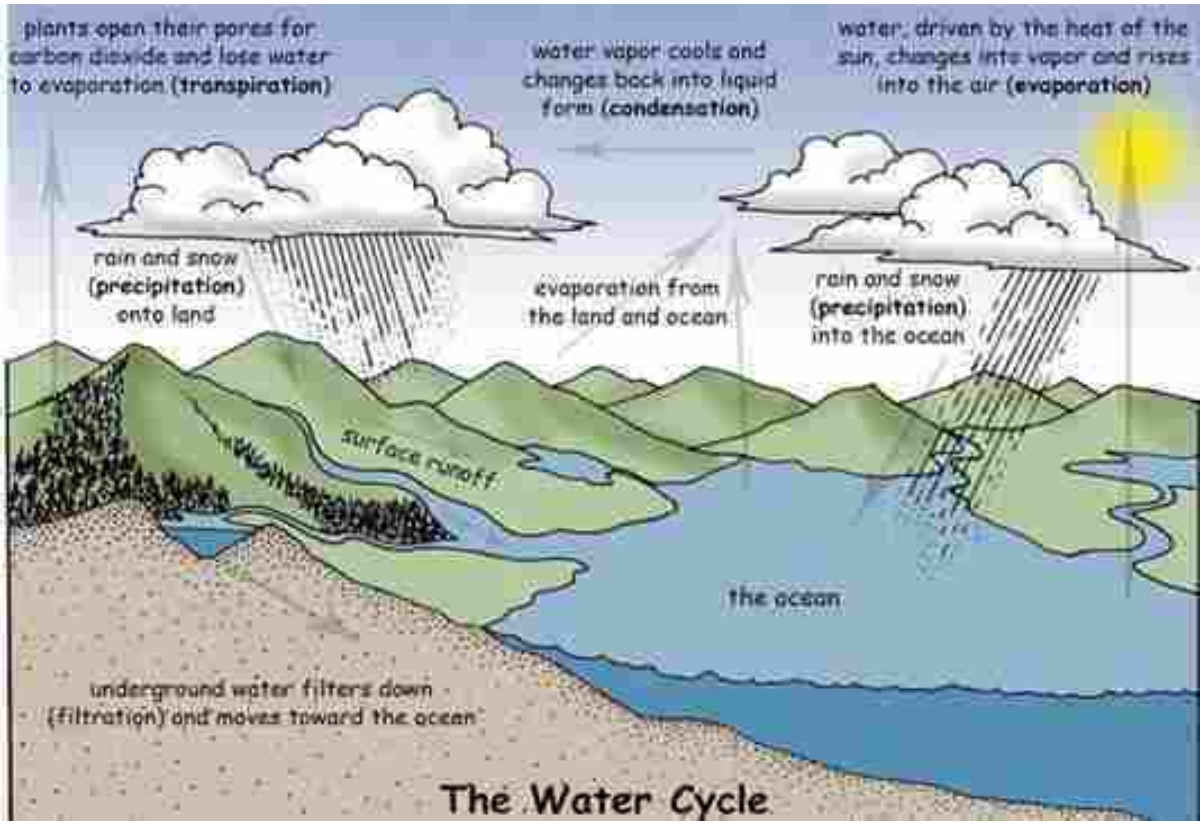
The water envelope

◆ Water Cycle in Nature

Water exists on or near the Earth's surface in a state of continuous change between its three states. Water is constantly moving from one place to another in many different paths that form a nearly closed system called the water cycle in nature or the hydrologic cycle. The water cycle as a system is capable of changing the Earth's surface physically, chemically, and biologically.

The water cycle in nature mainly includes the process of evaporation, which contributes to the formation of clouds and the process of rain or snowfall. In addition to other biological processes such as transpiration in plants, respiration in plants and animals, and water leakage through the pores of soil and sedimentary rocks to form groundwater.

Water vapor in clouds may react chemically with compounds in the air, forming some acids that fall as acid rain, which decomposes rocks.



Research activity

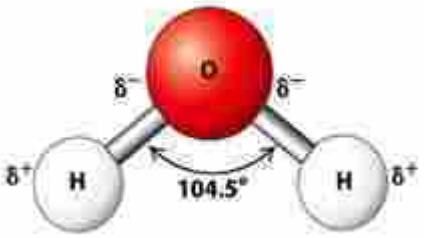
Using various sources, research about :

1- What are the different tools that meteorologists use to measure the amount of annual rainfall that falls on a particular area of the Earth's surface ?

2- Can scientists predict future changes in the Earth's water cycle?

◆ Chemical structure of water:

Water is composed of the two elements hydrogen and oxygen, in the ratio of 2: 1 by volume, respectively. Oxygen represents 88.89% of the mass of the water molecule and hydrogen represents 11.11%. The two hydrogen atoms are connected to the oxygen atom by two covalent bonds with an angle of about 104.5° between them.

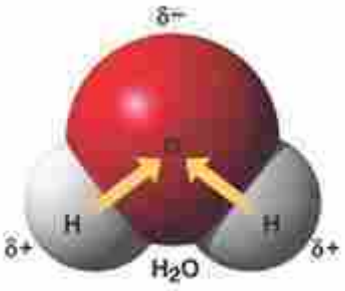


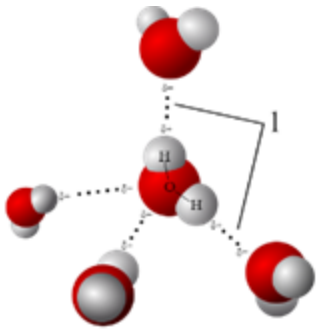
◆ Chemical properties of water:

Water does not exist on Earth in a pure form as it contains many ions and chemicals that interact with it in different ways. Here are three of the main properties of water:

1- Water polarity:

The oxygen atom is characterized by its higher electronegativity than the hydrogen atom, so the bonding electrons are attracted towards the oxygen atom, forming a partial negative charge on the oxygen atom and a partial positive charge on the hydrogen atom, which is known as the polarity of the water molecule. The polarity of water molecules causes them to bond with other water molecules or polar molecules of other substances to form hydrogen bonds, which gives water the ability to dissolve many salts and break them down into hydrated ions.



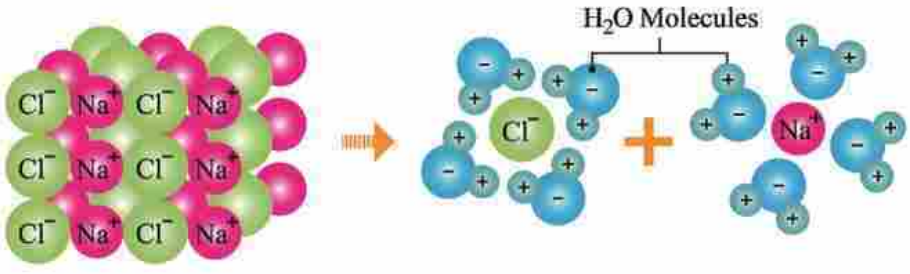


Example

Dissolving sodium chloride salt in water

$$NaCl_{(s)} + H_2O_{(l)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

$$NaCl_{(s)} \xrightarrow{H_2O} Cl^-_{(aq)} + Na^+_{(aq)}$$



The ability of water molecules to form hydrogen bonds with each other is also a key reason pure water has a higher boiling point of 100°Cat normal atmospheric pressure than compounds of similar structure, such as hydrogen sulphide, which boils at -61°C.

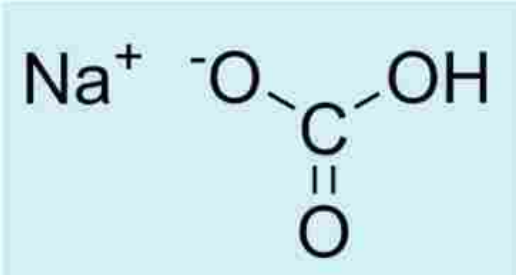
Hydrogen sulphide

Water

2-Hydrolysis (hydration):

A small percentage of water molecules exist as hydrogen ions (H^+) and hydroxide ions (OH-). As a result of chemical reactions of water with different compounds, hydrolysis of some salts, present in natural water, may occur. This hydrolysis affects the balance of these ions in water, leading to acidity or alkalinity of the water.

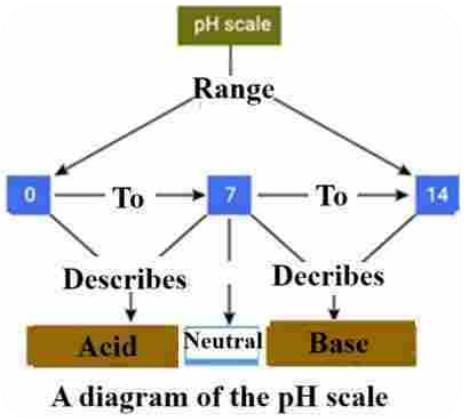
A practical example:



When table salt (NaCl) is added to water, it dissociates into sodium ion (Na^+) and chloride ion (Cl^-) and the salt ions remain in solution without binding to water ions, making the solution neutral because the concentration of hydrogen ions (H^+) is equal to the concentration of hydroxide ions (OH^-).In the case of sodium bicarbonate salt ($NaHCO_3$), hydrolysis of the salt leads to a decrease in the concentration of hydrogen ions (H^+) and an increase in the concentration of hydroxide ions (OH^-), making the salt solution basic. The opposite happens when ammonium chloride salt (NH_4Cl) dissolves in water; it hydrolyses and causes a decrease in the concentration of hydroxide ions and an increase in the concentration of hydrogen ions, making the salt solution acidic.

3- Acid-base balance (equilibrium) :

The acid-base balance in water depends on the relationship between the concentrations of hydrogen ions (H^+) and hydroxide ions (OH-). This relationship can be recognized by the pH value of the solution. It is a scale that ranges from 0 to 14. If the concentration of H^+ increases, the water becomes acidic and the pH value is less than 7, if the concentration of OH- increases, the water becomes basic and the pH value is greater than 7, while if the concentration of the two ions is equal, the water is neutral and the pH value is equal to 7.



A diagram of the pH scale

pH value: It is the measure of the acidity or basicity of liquids or solutions. The pH value of pure water is about 7, which is considered neutral. However, this value may vary in natural environments, affecting the organisms that live in them.

The pH value of water from different sources:

1- Seawater: The pH value of seawater generally ranges from 7.5 to 8.4, depending on the region in which the sea is located and the environmental factors surrounding it.
2- Fresh water (rivers and lakes): The pH value varies and normally ranges from 6.5 to 8.5
3- Distilled water: The pH value is around 7, because it is free of most of the impurities and ions that contribute to the acidity or alkalinity of natural water sources.
4- Groundwater: The pH of groundwater varies from one region to another depending on several factors, the most important factor is the rock structure of the area. Groundwater is either neutral or alkaline, and its pH value varies due to exposure to salts of certain rocks such as calcium carbonate or magnesium carbonate.
5- The pH of the clouds is generally slightly acidic, with values ranging from 4.5 to 5, due to the presence of carbon dioxide and other acidic gases dissolved in the rain droplets.

These values can vary depending on different environmental factors, and human activities in that area which can affect the pH level when forming clouds or rainwater

Practical activity

Measuring the pH values in different water samples:

To measure the pH value of different water samples (sea water, river water, and spring water), you can perform the following experiment:

Required materials:

1- Water samples (seawater, river water, and spring water)
2- A pH meter or pH test strips.
3-Cups for the samples.
4- Distilled water (for calibration)
5-Stirring rod

The procedures for the experiment:

1- Calibration: Calibrate the pH meter according to the manufacturer's instructions using distilled water.
2- Sample preparation: Number the beakers according to the type of water and place a small amount of this type in each beaker.
3- Testing: Immerse the electrode of the calibrated pH meter in each sample and record the reading when it stabilizes.
4- Measuring by using test strips: When using test strips, dip the strip into each sample for few seconds, then compare its colour against the attached chart to determine the approximate pH value

Research activity

With a group of your colleagues, do research using data that show the different pH values of clouds and rainfall in different regions and the reasons for this. Examples for these regions are,

A. Industrial cities **b. Agricultural areas** **c. Coastal cities**

To minimize the negative impacts on water quality and on the health of living organisms because of hydrolysis of salts and its effects on water, it is important to closely monitor salinity levels as well as the changes in ionic structure of natural water bodies.

Proper waste disposal minimizes the addition of harmful salts to water bodies and maintains water quality for wildlife habitats and human consumption.

Check your understanding

(1) Choose the correct answer : Which of the following represents the proportion of fresh water on the Earth's surface?

Ⓐ ○ 1% Ⓑ ○ 3% Ⓒ ○ 70% Ⓓ ○ 97%

(2) Explain how a change in the pH value of a river's water could affect the surrounding ecosystem. Propose suggestions for improving the water quality of this river .

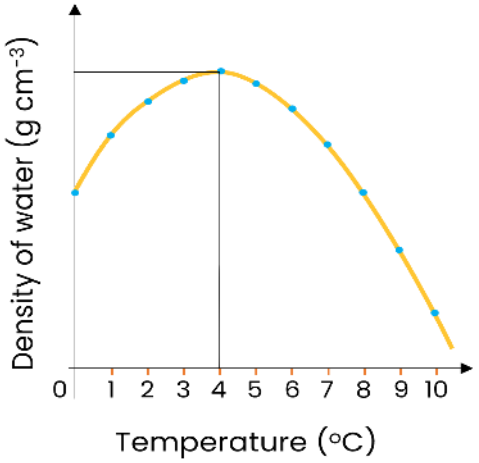
(3) Design an experiment that examines the effect of different chemicals on water quality and identify how the results of this experiment can be used to preserve aquatic environments

1-2 physical properties of water and their role in the distribution of living

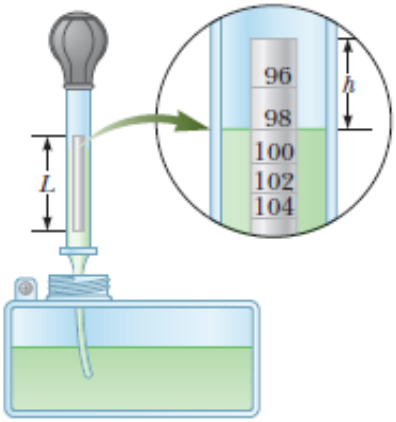
Water has unique physical properties that distinguish it from other fluids (liquids and gases), such as the decrease in its density when it reaches the freezing point and the high value of its specific heat, which affect many natural phenomena, and the distribution of living organisms in different environments.

Density

It is the mass of a unit volume of matter at a given temperature. Because matter is made up of molecules, the density of matter depends on the mass of the molecules and the distances between them.
In case of pure water, the mass of 1 cm^3 of it at a temperature of 4°C equals 1 g, that is, the density of water at 4°C equals 1 g/cm^3, which is equivalent to 1000 kg / m^3 in the international unit of density, and as the temperature of water decreases from 4°C to its freezing point, its density decreases as shown in the opposite graph. The ratio between the density of a given substance and the density of pure water at the same temperature is known as the relative density of the substance



The density or the relative density of liquids is measured by hydrometer, which is a sealed hollow glass reservoir with a wider bottom for buoyancy, containing lead (or mercury) balls for vertical stabilization and connected to a long, small-diameter glass stem that is graduated in units of density so that the lower scale indicates the highest density measured by the hydrometer and the higher scale indicates the lowest density measured by the hydrometer .

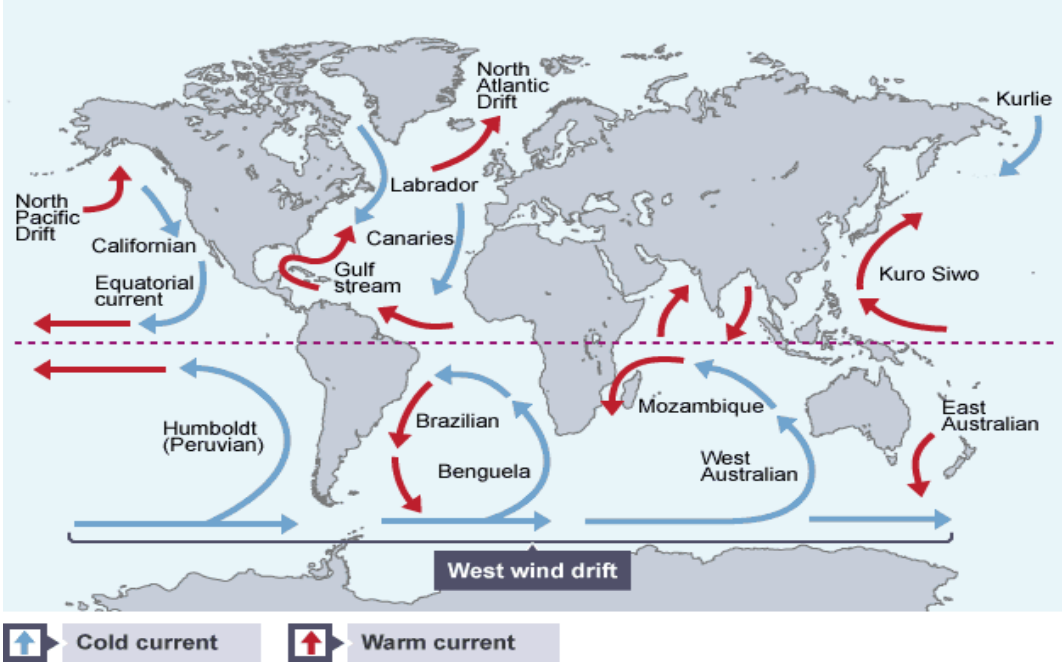


Practical activity: Measure the density of different samples of water
Use a hydrometer to determine the density of water from different sources: (sea, river, canal, pond, lake, underground) .
Discuss how the hydrometer can be used to predict the presence of soluble pollutants in a sample of water.

Water density and water currents in the oceans:

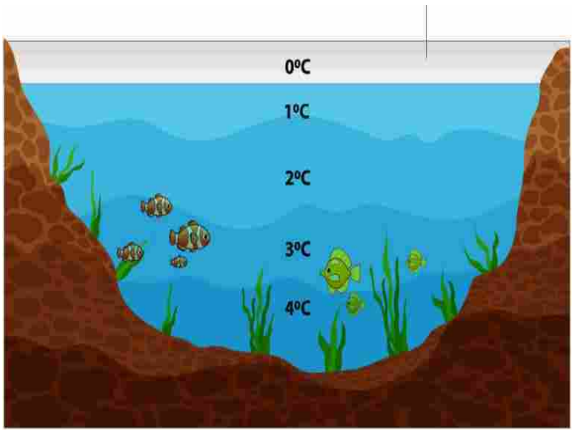
The density of water in the oceans is affected by the pressure inside the oceans, the amount of salt dissolved in it, and its temperature. As the pressure increases with increasing depth, the water molecules get closer together, and therefore the density of the water increases. Density is also affected by the amount of dissolved salt (salinity) in the water. The higher the salinity of water, the higher its density. The normal salinity of ocean water is 35 grams per liter of water (or the equivalent of two teaspoons per cup of water). Finally, the temperature of the water affects its density. The lower the temperature of water (down to 4°C), the closer the molecules are to each other, the lower the volume they occupy and the higher the density of water.

The differences in water density are one of the causes of water currents in oceans. These water currents carry heat and salt from the tropics to the poles, nutrients from the deep ocean to the surface, and fresh water from rivers or melting snow to different places when these currents travel around the globe.



Density of water in Polar Regions

The density of water changes as its temperature changes, generally the volume of a liquid increases as the temperature increases and the volume of a liquid decreases as the temperature decreases. Water is an exception to this rule. As the temperature of pure water increases from 0°C to 4°C, the water shrinks and as a result its density increases, and the density of water reaches its highest value (1000 kg/ m^3) at 4°C. Water expands as the temperature rises above 4°C, so its density decreases.



This helps to understand why a lake in polar regions starts to freeze at the surface rather than at the bottom. When the air temperature is between 4°C and 0°C, the surface water of the lake expands, becoming less dense than the water below it. Finally, the surface water freezes, and the ice remains on the surface as the density of the ice is less than the density of the water while the water remains near the bottom at 4ºC. If not, fish and other marine life would not survive.

Practical experiment

The effect of the difference in density on the movement of water

Prepare ice cubes and add food dyes to the water before it freezes, so that it is easy to observe the melting process of the ice cubes and the direction of water movement after it melts.

Put one ice cube in a quantity of fresh water, and another ice cube in an equal quantity of salt water with the salt concentration equal to the salt concentration in ocean water at room temperature .

-In which case does the ice cube dissolve at a faster rate?

-What are your observations about the movement of water resulting from the melting of each cube?

This is already happening in the ocean! If fresh water from melting icebergs enters the ocean, that fresh water spreads out on the surface of the ocean and does not sink. If the freshwater freezes, it forms an insulator between the deeper parts of the ocean and the cold atmospheric air above.

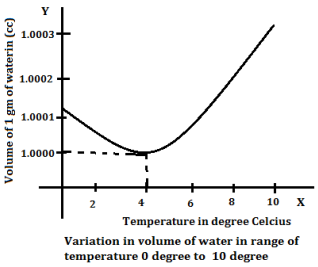
Check your understanding

(1) Analyze the opposite graph and conclude what happens to the density of water as the temperature changes .

_____

(2) Give an example of how a change in temperature and density of water affects organisms in an aquatic environment.

_____



Variation in volume of water in range of temperature 0 degree to 10 degree

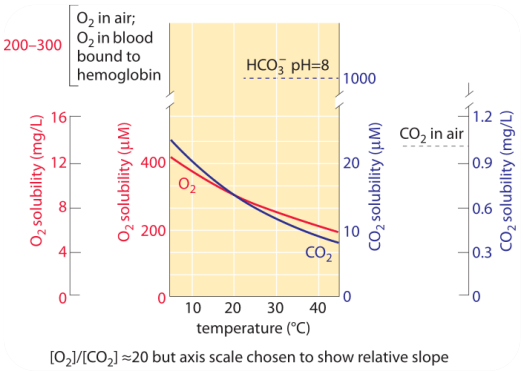
1-3 Oxygen and carbon dioxide in the aquatic

Rivers and seas naturally contain sufficient levels of oxygen and carbon dioxide to keep aquatic life of plants, fish, and microorganisms such as bacteria and algae .

The main source of oxygen in water is atmospheric air, where oxygen is slightly soluble in water. In addition, phytoplankton, algae, and aquatic plants produce oxygen in water in the process of photosynthesis. In seas and oceans, more oxygen dissolves in water as a result of waves and water currents in the ocean, which increase the rate of gas exchange between the atmosphere and water .
Overall, these natural processes provide marine creatures with the oxygen necessary for their survival

Solubility of the two gases O_2 and CO_2 in water

The concentration of oxygen gas in the air is about 500 times higher than that of carbon dioxide, but oxygen gas is about 50 times less soluble in water. The solubility of the two gases in salty ocean water is about 20-30% lower than their solubility in fresh water.
In general, the solubility of the two gases decreases at higher temperatures. As the temperature increases, the percentage of CO_2 dissolved in water decreases, but at a greater rate than the percentage of oxygen in water.



The graph shows the relationship between the solubility of oxygen and carbon dioxide in fresh water at different temperatures under normal atmospheric composition.

The effect of increasing the percentage of dissolved oxygen in water:

a. Enhancement (improving) of respiration: Aquatic organisms depend on dissolved oxygen in water for respiration. Increasing the amount of oxygen in water improves their ability to breathe.

b. Improved metabolism: High levels of dissolved oxygen can support the metabolism of aquatic organisms and improve growth.
c. Increased activity: Adequate levels of dissolved oxygen stimulate aquatic organisms to be more active in swimming, hunting, and reproduction.
d. Maintain balance of the ecosystem: A healthy level of dissolved oxygen in water is critical in maintaining a stable aquatic ecosystem by supporting diverse populations of fish, invertebrates, and plants.

Research activity

Search about the factors that lead to the lack of oxygen gas in water and the effects of the lack of this gas.

Sources of carbon dioxide in the aquatic environment:

1- The atmosphere is the main source of carbon dioxide (CO_2) in water. Carbon dioxide is exchanged between the atmosphere and water.

2- Marine organisms produce carbon dioxide gas that dissolves in the surrounding water as a waste product of their metabolism.

3- Human activities such as industrial pollution, and the decomposition of organic matter carried by agricultural wastewater.

The effect of increased CO_2 in water on aquatic organisms:

Increased CO_2 in water can have several negative effects on aquatic organisms, including:

1. Acidification: When CO_2 levels are high in the atmosphere, it can dissolve in greater amounts in water, leading to an increase in carbonic acid and a decrease in the pH value of the water. This acidification can be harmful to many species of aquatic organisms, especially those in sensitive life stages such as the egg and larval stages.

2. Weak respiration: High levels of carbon dioxide can reduce the amount of dissolved oxygen in the water necessary for aquatic organisms to breathe.

3. Reduced calcification: Many marine organisms such as corals, mollusks, and some species of plankton depend on calcium carbonate to form their shells or skeletons. Increased CO_2 converts it into calcium bicarbonate, which dissolves in water, disrupting the ability of these organisms to build or maintain their skeletons.

The effect of CO_2 deficiency in water on aquatic organisms:

1. Reduced photosynthesis: Aquatic plants and algae need carbon dioxide for photosynthesis. Decreasing the availability of CO_2 in water may limit their ability to produce energy, affecting the overall productivity of the ecosystem.

2. Effects on food chains: A change in the level of CO_2 in the water can affect productive organisms such as phytoplankton and algae, thereby affecting organisms at higher levels of the food chain.

3. Disruption of pH balance: Low concentrations of CO_2 may lead to an increase in the pH of water, negatively affecting sensitive species that are adapted to a certain pH range

1-4 Biological adaptations of living organisms in the aquatic environment

Get ready

In the world of aquatic creatures, every organism has a set of adaptations that help it to survive in its environment, whether it is a deep ocean or a shallow lake. In this lesson, we will explore these physiological, behavioral, and structural adaptations that allow aquatic organisms to survive under different environmental conditions.

Learn

Physiological (functional) adaptation:

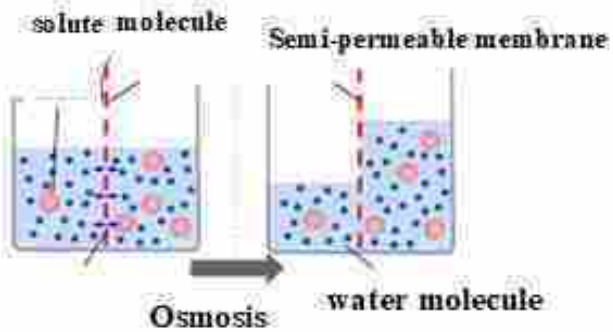
Organisms in the aquatic environment develop special physiological adaptations that enable them to survive in their environments. That is, adaptations or modifications in the way they perform their biological/vital functions. For example, some deep-ocean fish have special abilities to regulate respiration under the state of oxygen deficiency. To adapt to the high-water pressure at great depths, deep-sea fish have strong and durable arteries and veins that can withstand the high pressure. They also have the ability to effectively adjust their blood pressure to equalize the external pressure.

Electric Eel

A famous example is the Electric Eel, which lives at depths of thousands of meters, where oxygen levels are extremely low. These fish have developed very large gills, with very fine capillaries that maximize the efficiency of extracting the little oxygen found in water. In addition, they can slow down their metabolism to minimize their oxygen needs.

Osmosis and osmotic pressure:

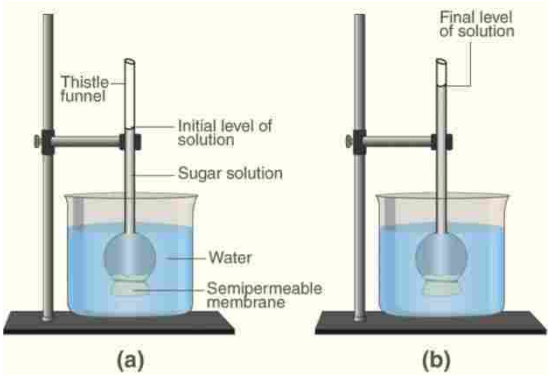
Osmosis is the phenomenon of water transfer from a dilute solution to a concentrated solution through a semi-permeable membrane separating the two solutions as shown in the figure.



Osmotic pressure is the pressure created in a solution due to the difference in solute concentration in the solution and leads to the diffusion of water from the less concentrated solution (low osmotic pressure) towards the more concentrated solution (higher osmotic pressure).

Practical activity:

Tools: Sugar solution - Thistle funnel - Cellophane paper - Glass beaker half-filled with tap water - Rubber band – Stand



Steps:

Tightly fix the cellophane paper to the opening of the funnel with the rubber band.

Fill the funnel with the sugar solution, submerge it in the water-filled beaker and hold it vertically.

Mark the solution level in the stem of the funnel

Leave the device for a sufficient period of time and observe what happens, and record your observations.

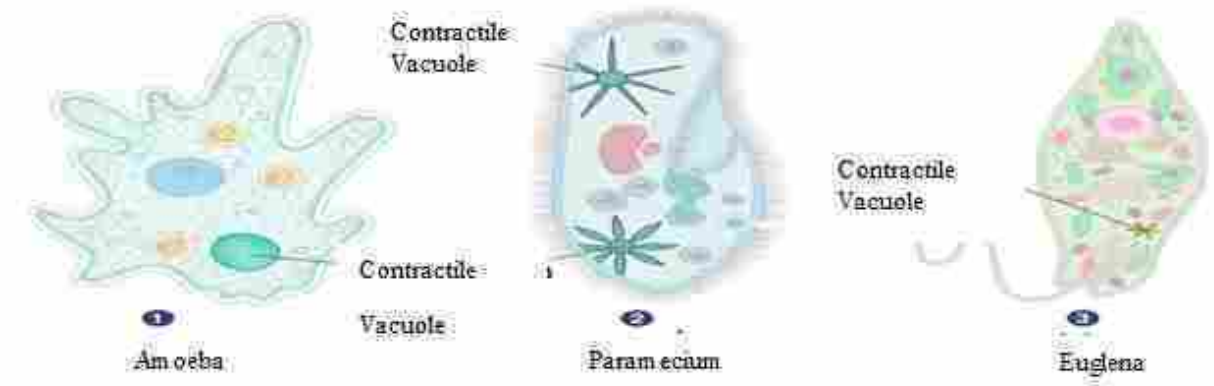
We can observe that the solution level in the funnel stem increases as it draws water from the beaker by osmosis, since the sugar concentration in the funnel is higher than its concentration in the beaker.

Physiological adaptations of freshwater organisms to low osmotic pressure

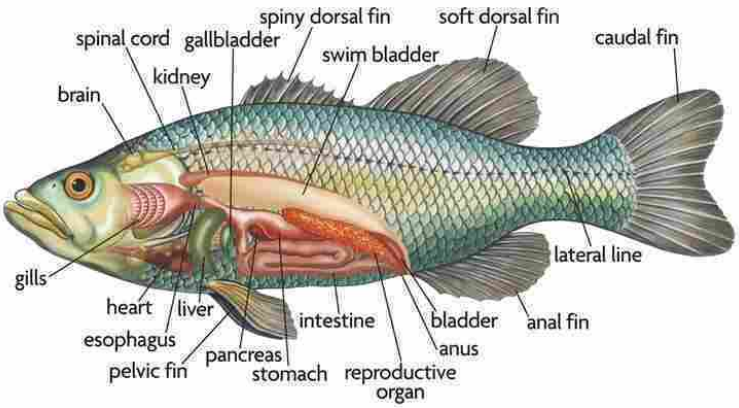
The previous experiment showed what could happen to an organism living in freshwater when the osmotic pressure of the water is lower than the osmotic pressure of their bodies.

In this case, the bodies of these organisms will draw large amounts of water, causing them to burst and die. So, how do these organisms adapt to the characteristics of the freshwater environment?

Unicellular organisms, such as amoeba, paramecium, and euglena, have a structure or an organelle called a contractile vacuole that collects excess water in the cell and when it is filled with water, it moves towards the cell membrane where it discharges its water content to the outside of the cell.



Multicellular organisms, such as fish, eliminate excess water that enters the body through the skin, mouth, and gills by the kidneys in the form of dilute urine. In fish, the kidneys are located in the abdominal cavity on either side of the spine.



While fish that live in saltwater need to swallow large amounts of sea water to compensate for the osmotic loss of water from their body, and then they excrete excess salts through their kidneys and specialized cells in their gills.

As a physiological adaptation to the high salinity of the ocean and sea water, sharks maintain the balance of water and salts within their bodies through controlling the level of urea in their blood. Urea is a nitrogenous compound that is excreted in the urine of many animals to get rid of it. Sharks keep a high concentration of urea in their blood, which increases their osmotic pressure, bringing it close to the osmotic pressure of the surrounding water. This helps minimize the loss of water from their body to the surrounding environment of high salinity.

Behavioral adaptations:

Behavioral adaptations include certain actions or behaviors that organisms use to avoid extreme conditions or to better utilize available resources. For example, some fish migrate between fresh and salt water to reproduce and survive.

Salmon migration

Salmon are born in freshwater, then move to the sea where they spend most of their adult life, before returning to rivers again to reproduce. When salmon eggs hatch, their young spend the first period of their lives in freshwater. During this stage, the youngsters adapt to the freshwater environment. Upon reaching a certain size, the fish undergo a biological process known as “Smoltification” which allows them to move to the saltwater of the sea. When salmon reach sexual maturity, they begin to return to the rivers where they were born to reproduce.

The ability of salmon to move between different environments is due to their ability to make complex physiological adaptations. For example, their circulatory and respiratory systems adapt to changes in salinity and different amounts of oxygen in fresh and salt water.

Structural adaptations

Structural adaptations include changes in the physical structure of organisms that help them survive in their environments. For example, fish that live in the deep ocean have very large eyes to be able to see in the dark, and their bodies are compressed to withstand the very high pressure in deep water. An example of a compressed deep-sea fish is the icefish, which lives in the cold southern oceans, at depths of about 2000 meters.

Ice fish

Among the general structural adaptations of fish are a streamlined body that reduces water resistance to the fish's movement, gills that enable it to extract dissolved oxygen in water, and its body is covered with scales and mucus to be waterproof and to reduce water resistance to its movement, fins are movement organs, and bony fish have an air bladder or swim bladder that helps them float in the water.

Gas exchange and cellular respiration:

Gas exchange is when an organism obtains oxygen from atmospheric air or the surrounding environment and removes carbon dioxide. Cellular respiration is a vital process in which the organism breaks down the bonds in food molecules, especially glucose, to obtain stored energy.

Unicellular organisms, such as amoeba obtain oxygen and eliminate carbon dioxide through the cell membrane by diffusion.

activity

Analyze the relationship between biological adaptations and the aquatic environment: Search the Internet to find biological adaptations found in both the lionfish and the colorful octopus

Colored Octopus

Lionfish

Check your understanding

Choose the correct answer:

(1) 1. Which of the following is a physiological adaptation in deep ocean fish?

Ⓐ ○ Compressed body
Ⓑ ○ Strong arteries
Ⓒ ○ Increasing blood pressure
Ⓓ ○ Large gills

(2) Which of the following adaptations enables deep-sea fish to cope with deficiency of oxygen?

Ⓐ ○ Slower metabolic rate
Ⓑ ○ Compressed body
Ⓒ ○ High concentration of salts in the cells
Ⓓ ○ Strong blood vessels

(3) What does smoltification represent in salmon?

Ⓐ ○ Behavioral adaptation
Ⓑ ○ Physiological adaptation
Ⓒ ○ Structural adaptation
Ⓓ ○ Physiological and structural adaptation

(4) Which of the following is a similarity between amoebas and fish?

Ⓐ ○ Cellular respiration
Ⓑ ○ Gas exchange organ
Ⓒ ○ Number of cells in the body
Ⓓ ○ Mechanisms of osmoregulation

(5) Which of the following helps minimize water resistance to fish movement in water?

Ⓐ ○ Scales only
Ⓑ ○ Mucus only
Ⓒ ○ Mucus and streamlined body
Ⓓ ○ Streamlined body, mucus, and scales

(6) Some physiological adaptations require the occurrence of certain structural adaptations. Give one example.

(7) What are the challenges that deep-water fish face and how do they adapt structurally to them?

(8) What is the effect of freshwater on the osmotic pressure of the cells of freshwater organisms, and how do they cope with this ?

1-5 The effect of temperature on the marine environment

Have you ever wondered how temperature affects marine organisms? Or why do the oceans stay warm even after the sun goes down? And why, on a hot summer day, does the air around you feel hotter quickly, while the water in lakes and rivers stays cooler?

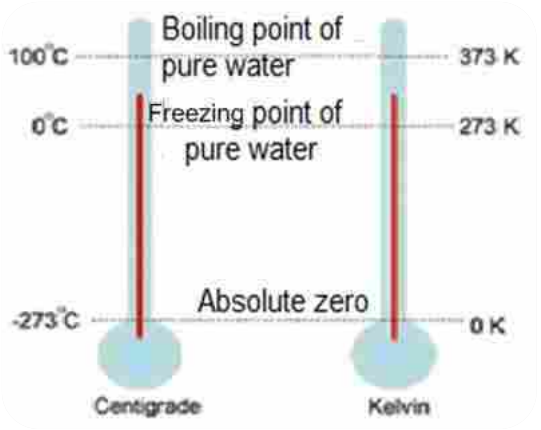
Heat and temperature

In everyday conversation, some people confuse the concepts of "amount of heat" and "temperature." Although they are related, there is a difference in their meaning in physics. Any object or system is made up of an enormous number of particles that are spaced apart and in constant motion. The sum of the potential energy due to the position of the particles relative to each other and the kinetic energy due to the motion of the particles is called the internal energy of the object or system

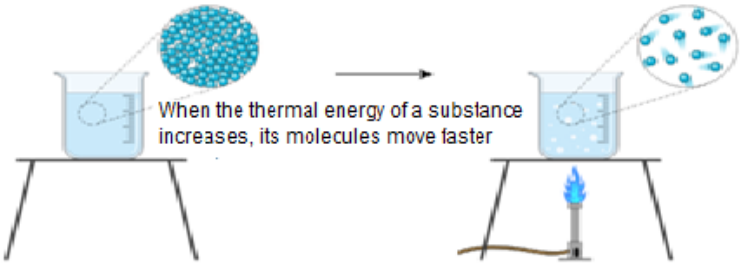
The concept of the amount of heat refers to the energy transferred from, to, or through an object when there is a temperature difference, and the amount of heat is measured in Joules (Joule)

Temperature is a quantitative description of how hot or cold an object or system is. It represents the average kinetic energy of the particles of that object or system, and its international unit is the Kelvin (K). To find the value of temperature in kelvin corresponding to its value in degree Celsius, the **relation used is:**

($T_K = t\ ^\circ C + 273$), knowing that an increase in temperature by one degree Celsius (°C) is equivalent to an increase in temperature by one Kelvin (K)



When an object or system gains thermal energy, the amplitude of vibration of the molecules, as well as their kinetic energy, increases, and so its temperature rises.



Does a unit of mass (1 kg) of different substances require the same amount of heat for their respective temperatures to rise by one kelvin?

The specific heat of some substances

Substance	Specific heat (J/kg.K)	Substance	Specific heat (J/kg.K)
Zinc	388	Lead	130
Liquid mercury	140	copper	385
Aluminum	897	Methanol	2450
Glass	840	Water vapor	2020
Carbon	710	Water	4180
iron	450	Ice	2060

Specific heat of matter (c)

The amount of heat gained by 1 kg of a substance that causes its temperature to rise by 1 K is called the specific heat of this substance, and its measuring unit is J/kg. K.

The higher the specific heat of a substance, the more thermal energy a given mass of this substance takes to raise its temperature by 1 K if compared with an equal mass of another substance with a lower specific heat.

The opposite table lists the specific heat of some substances.

The amount of heat gained or lost by an object (Q_{th}) can be calculated from the relationship:

$$Q_{th} = m\, c\, \Delta t$$

Where m: the body mass , **Δt:** the amount of change in body temperature

Example

Calculate the amount of heat required to raise the temperature of 0.3 kg of copper from 20 degrees Celsius to 70 degrees Celsius given that the specific heat of copper = 385 J/kg. K.

solution

$$Q_{th} = m\, c\, \Delta t = 0.3 \times 385 \times (70-20) = 5775\ J$$

Example

A piece of aluminum with a mass of 200g and a temperature of 80 °C is dropped into a quantity of water at room temperature. If the final temperature of the system is 40 °C, calculate the amount of heat gained by the amount of water. The specific heat of aluminum is 897 J/kg. K

solution

Based on the law of conservation of energy, the amount of heat gained by the water is equal to the amount of heat lost by the aluminum piece, assuming no thermal energy leaked or lost from the system. (Use international units.(

$$Q_{Al} = m_{Al} \cdot c_{Al} \cdot \Delta T_{Al}$$

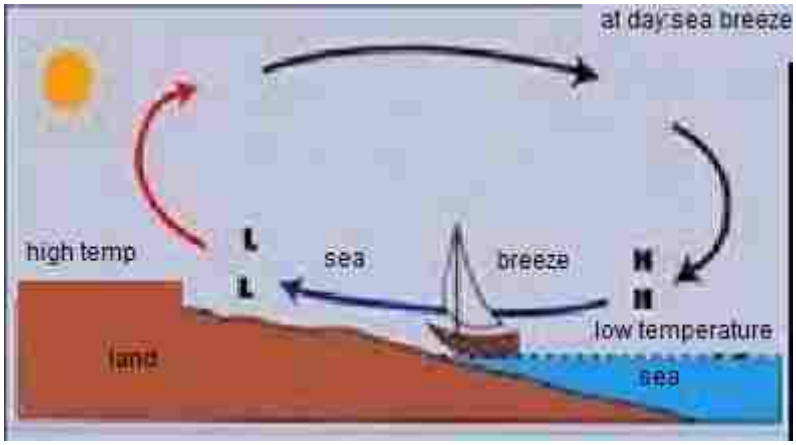
$$Q_{Al} = (0.2\ kg)\ .\ 897\ J/kg.\ K) \cdot (40°C - 80°C)$$

$$Q_{Al} = -7176\ J$$

The negative sign here indicates that the aluminum piece has lost heat to the water sample, so the amount of heat transferred to the water is 7176 J

The importance of the high specific heat of water:

The specific heat of water is high compared to other substances and is roughly equal to 4200 J/kg. K due to the presence of hydrogen bonds between its molecules, making it partially responsible for the mild climate near large bodies of water. The temperature of a large body of water during the summer is low compared to the temperature of beach sand and rocks. Air over land heats up, becomes less dense, and rises upward. Cooler air from above the surface of the water moves landward, and is called the **sea breeze**, to replace the hot air that has risen upward, as shown in the figure.



Analytical activity:

Analyze the data in the table and then answer the following questions:

1) What are the factors that affect the specific heat of matter?

2) Which of the three states of water has the greatest value of specific heat?

The matter	Its temperature	The Physical state	Specific heat J/kg. K(C)
air	25°C	Gas	1003.5
lead	25°C	Solid	129
Pure water	25°C	Liquid	4181.3
Water vapor	100°C	Gas	2020
ice	0°C	solid	2090

The effect of temperature changes on marine organisms:

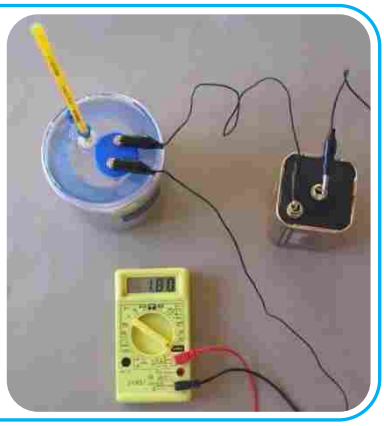
Temperature changes in the oceans affect the distribution of marine organisms. Organisms that live in warm surface waters may be unable to survive in colder depths. For example, coral reefs need specific temperatures to survive, and a change in temperature due to climate change may lead to their death.

The high specific heat of water plays a large role in the relative stability of water temperature in seas and oceans as water can absorb a large amount of heat without a significant change in its temperature

This makes the oceans and lakes huge thermal reservoirs, because during the day the water absorbs large amounts of solar energy without getting too hot, and then slowly releases this energy at night, helping to maintain stable temperatures in the surrounding marine environment. This thermal balance is very important for the sustainability of marine life. This property protects marine organisms from rapid changes in temperature, especially cold-blooded creatures **(Poikilotherms),** whose body temperature depends on the temperature of the surrounding environment. For this reason, we often find these organisms in the deep seas and oceans where the temperature is stable.

Probe and investigation (activities)

Use different sources to find out how to measure the specific heat of water using Joule calorimeter.



Check your understanding

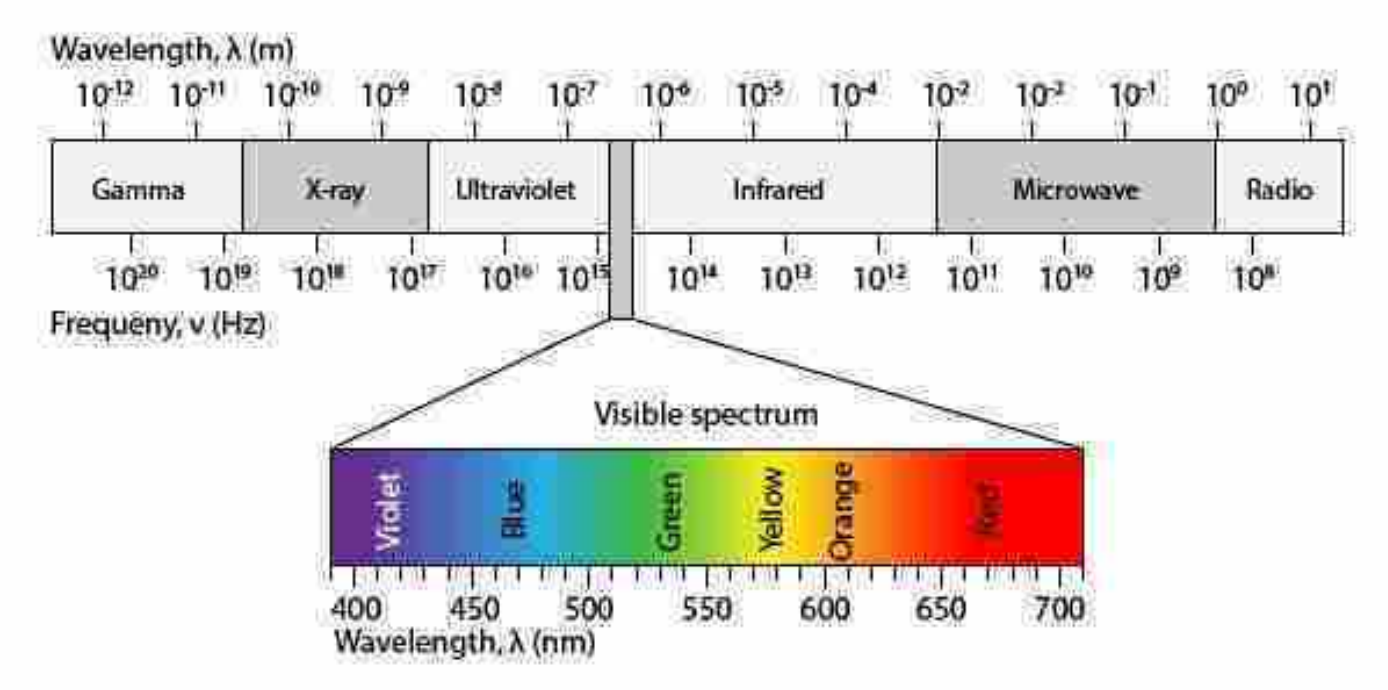
1.Given the different specific heats of land and seawater, explain the phenomenon of the sea breeze.

2.Explain why the specific heat of water is a critical factor in the sustainability of marine life.

3. What are the factors that affect the amount of heat lost or gained by a substance when its temperature changes?

1-6 The effect of light and solar radiation on aquatic

Imagine you are diving into the sea, and you observe how the intensity of light changes as you dive deeper into the water. You may wonder: How does this affect the organisms that live in the depths? How does light in different layers of water affect photosynthesis? and what role does solar radiation play in maintaining the ecological balance in the oceans?

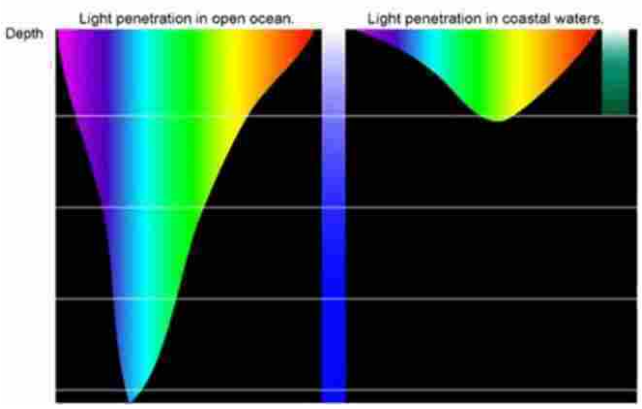


Solar radiation refers to the energy produced by the sun, some of which reaches the Earth. It serves as the primary source of energy for most processes in the atmosphere, hydrosphere, and biosphere. Solar radiation can be converted into other forms of energy, such as heat and electricity, using various technologies. The technical and economic **feasibility** of these technologies depends on the available resources of solar radiation.

Visible light is a part of the electromagnetic spectrum, which propagates as electromagnetic waves that differ in their wavelengths (λ) and frequency (ν). Visible light represents only a small portion of this spectrum and is composed of different wavelengths, known as the colors of the visible spectrum (these colours are red, orange, yellow, green, blue, indigo, and violet).

Solar radiation reaching Earth can be classified into two categories:

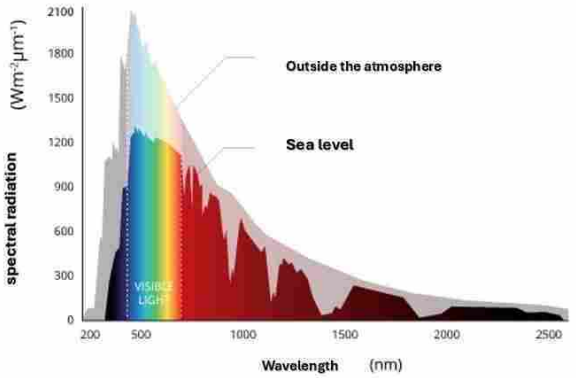
- Direct solar radiation: This is the radiation that reaches the Earth's surface without scattering.
- Indirect solar radiation: This is the light which scattered while passing through the atmosphere.



The amount of solar radiation reaching a specific location or a certain object on Earth's surface depends on several factors such as geographic location, season, time of day, cloud cover, and altitude .

Solar radiation and its effect on water:

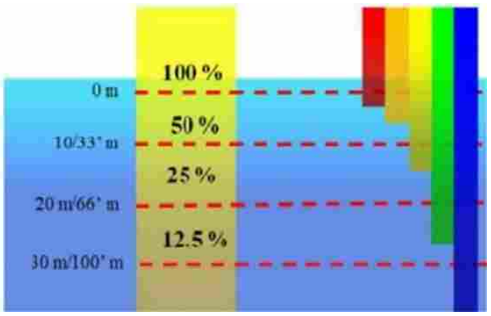
Solar radiation is the primary source of energy on Earth, and it directly affects the various layers of water. When sunlight penetrates the water's surface, part of it is absorbed by water, suspended matter, and aquatic plants, while the other part scatters in the depths.



light zones in water:

As water depth increases, the intensity of light gradually decreases. This light gradient defines different zones in the oceans, such as the euphotic (sunlit) zone, the twilight (mesopelagic) zone, and the aphotic (deep) zone. Marine organisms inhabit these zones according to their ability to adapt with the available light.

When sunlight hits the ocean surface, part of it is reflected into the atmosphere. The amount of energy that penetrates the water's surface depends on the angle of the sun's rays. A greater amount of light penetrates the water when the sun's rays are perpendicular to the surface, while less light penetrates when the rays are inclined or tilted. Water absorbs nearly all infrared energy from sunlight within the top 10 centimeters of the surface.



Depth not only affects the absorption of light colors but also the light intensity. The light intensity decreases gradually as it travels through the water. At a depth of 10 meters, more than 50% of visible light energy is absorbed. Even in clear tropical waters, only about 1% of visible light—mostly in the blue spectrum—reaches a depth of 100 meters.

This diagram illustrates the difference in light penetration in shallow coastal waters and the open ocean. When different colors of the light spectrum penetrate ocean waters, warmer colors, like red and orange (with longer wavelengths), are absorbed, while cooler colors (with shorter wavelengths) are scattered.

Photosynthesis in the aquatic environments:

Many autotrophic organisms, such as aquatic plants, algae, and phytoplankton, rely on photosynthesis to convert solar energy into chemical energy which is used to produce organic compounds necessary for growth and survival. This process heavily depends on light availability and, therefore, mainly occurs in the surface layers of water bodies where light can reach these organisms.

Solar radiation and ecological Balance:

Solar radiation is a vital factor in maintaining ecological balance in aquatic environments. It does not only affect photosynthesis—an essential process for marine life—but also directly influences water temperature and the distribution of marine organisms

.

The Effect of Solar Radiation on Ecological Balance in Aquatic Environments:

The role of solar radiation in the distribution of marine organisms:

Marine organisms are unevenly distributed in water depending on their light and energy needs. Organisms that rely on photosynthesis, such as algae and phytoplankton, are abundant in the surface layers where solar radiation is plentiful. For example, coral reefs thrive in warm shallow waters near the equator, where solar radiation is available all year round. This radiation stimulates the growth of symbiotic algae living within coral tissues, providing the coral with nourishment.

The effect of solar radiation on water temperatures:

Solar radiation directly impacts water temperatures, which in turn affects the distribution of marine organisms. Warm waters resulting from solar radiation in tropical regions attract specific types of fish and marine animals that require certain temperatures to survive and reproduce. For instance, tropical fish such as tuna and barracuda live in warm waters, while other species like cod prefer colder waters found farther from the equator.

Changes in solar radiation intensity:

Variations in solar radiation intensity due to seasonal changes or climate changes can lead to disruptions in ecological balance. For example, in polar regions, where solar radiation is low or absent during the winter, photosynthesis rates drop significantly, affecting the food availability for marine organisms. This can lead to a decline in the numbers of organisms that rely on photosynthesis, thus impacting the entire food chain. On the other hand, global warming causes rise in water temperatures, leading to the death of coral reefs, which significantly affects the marine organisms' dependence on coral reefs.

The effect of solar radiation on ocean currents:

Solar radiation also contributes to the formation of ocean currents, which play a crucial role in distributing heat and nutrients throughout the oceans. These currents influence the distribution of marine life and make certain areas rich in food resources. For example, the Gulf Stream carries warm waters from the equator to the North Atlantic, moderating the climate in regions like Western Europe and enhancing marine biodiversity.

Research and investigation (activities)

Activity 1: Measuring light intensity in water
aim: The student tests the light intensity of water at different depths.
Tools: Light intensity meter, large basin of water, different light sources, ruler.
Steps:
1.Place the light source above the aquarium.
2.Use the light meter to measure the intensity of light at different depths.
3.Record the results and discuss the effect of depth on light intensity.

Check your understanding

1) How does the light gradient affect the distribution of marine organisms in the deep ocean?
2) Why is photosynthesis important for maintaining ecological balance in the oceans?

1-7 The effect of water pressure on living organisms

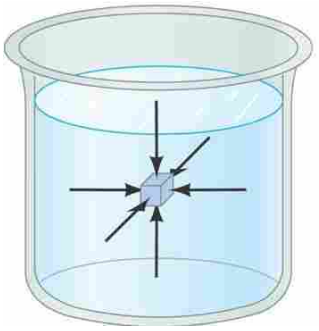
Deep ocean organisms face a harsh environment that requires unique adaptations to survive, including living under immense water pressure. So how does water pressure affect deep-sea organisms?

And how do physiological adaptations help these organisms survive under this immense pressure?

Fluids are substances characterized by their ability to flow and include liquid and gaseous substances. While gases are characterized by their ability to compress easily and take up space, liquids resist compression and therefore keep their volume almost constant.

Pressure at a point inside a liquid

A liquid has a pressure at any point inside it equal to the weight of the liquid column above that point acting on the unit area of that point. If an object is at that point, it experiences a force due to this pressure that is perpendicular to its surface.



The force due to the pressure exerted on an object, which is due to the presence of this object inside the liquid is calculated from the relation, and its unit is Newton(N).

$$\mathbf{F = P \times A.}$$

Where P is the pressure at a point in N/m^2, and A is the surface area in m^2 exposed to the pressure.

The pressure of a liquid (P_{liquid}) at a point inside this liquid, located at a depth (h) from its surface is calculated from the relation

$$\mathbf{P_{liquid} = \rho\ g\ h}$$

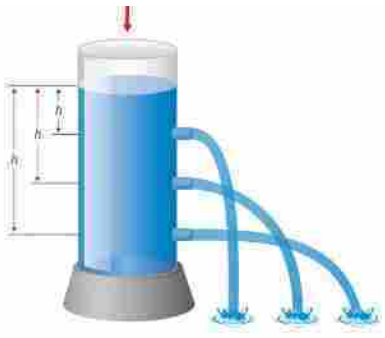
Where ρ is the density of the liquid in kg/m^3, g is the acceleration due to gravity in m/s^2

And if the surface of the liquid is subjected to atmospheric pressure (P_a), then the total pressure acting on the point is calculated from the relation

$$\mathbf{P_{total} = P_a + P_{liquid} = P_a + \rho\ g\ h}$$

The Factors affecting the magnitude of the liquid pressure at a point inside it:

From the previous discussion we can conclude that:



The liquid pressure P at a point inside it increases as the depth of that point (h) below the surface of the same liquid increases. The liquid pressure increases with increasing the density of the liquid (ρ).

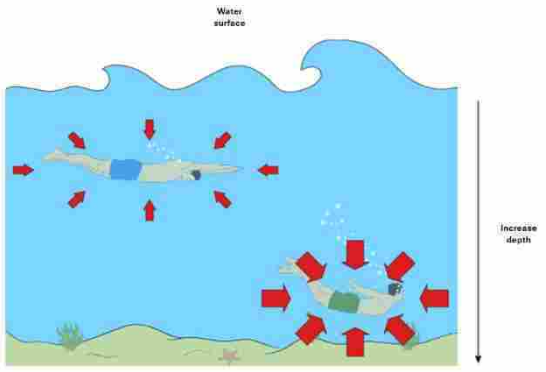
The pressure is measured in units of N/m^2, which is equivalent to the Pascal unit.

In practical fields, we use a larger unit, the bar.

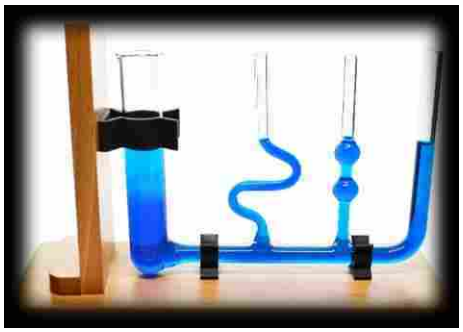
$$\mathbf{1\ Bar = 10^5\ Pascal = 10^5\ N/m^2}$$

Properties of liquid pressure

The pressure at a point inside a liquid act in all directions equally. If the pressure at a point in a certain direction is equal to (P), then the pressure in any other direction at that point is equal to (P).



The pressure is the same at all points which lie in the same horizontal plane (level) in a homogeneous static (stagnant) liquid. This explains the property of connecting vessels, where the liquid in vessels connected together rises to the same horizontal plane in all vessels regardless of their shape or cross section. It explains why the water level in connected seas and oceans is at the same horizontal level.



The horizontal level of the sea surface is used as a reference level called "sea level" to measure the **altitudes** around the globe.

Example

An aquarium base of an area of 1000 cm^2 contains water of the weight 4000 N, what is the magnitude of water pressure acting on the bottom of the aquarium?

solution

$$P_{liquid} = \rho g h = \frac{F_g}{A} = \frac{4000}{1000 \times 10^{-4}} = 4 \times 10^4 \ N/m^2$$

Example

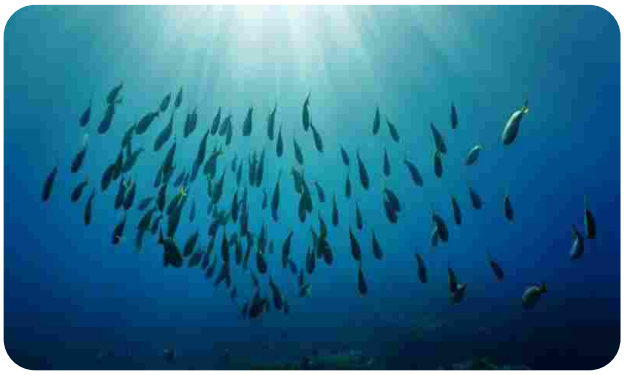
Calculate the total pressure exerted on a swimmer at a depth of 10 m from the surface of a lake of water if you know that the water density is 1000 kg/m^3, the acceleration due to gravity is 10 m/s^2, and the atmospheric pressure at the surface of the lake is 1.013×10^5 N/m^2

solution

$$P = P_a + P_{\text{سائل}} = P_a + \rho g h = 1.013 \times 10^5 + (1000 \times 10 \times 10) = 2.013 \times 10^5 N/m^2$$

Water pressure

Water pressure is the pressure exerted by water on an object under the surface of water. This pressure increases as the depth increases due to the increase in weight of the water above the object. At sea level, the pressure is equal to atmospheric pressure (1atm = 1.013×10^5 N/m^2), and water pressure increases by approximately 1 atm for every 10 m below the surface. For example, at a depth of 100 m, the pressure caused by water will be about 10 times greater than the atmospheric pressure. In the deep sea, the pressure is very intense (unimaginable), yet many creatures can adapt to high water pressure.

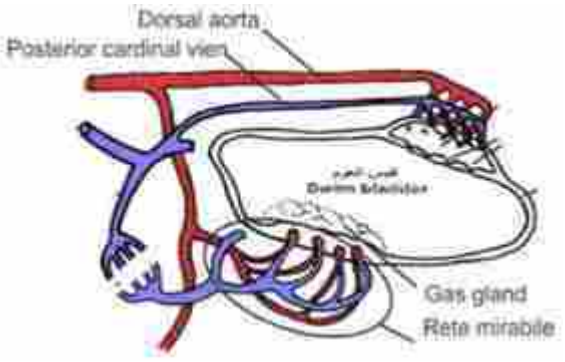


The effects of pressure on the biological adaptations of creatures

First: The swim bladder (air bladder)

The surface water organisms:

The organisms that live near the water surface face relatively low water pressure, and therefore their physical or body structure is less strong than those that live in the depths.



Organisms in the intermediate depths:

At great depths, such as 200 m to 1000 m, organisms are more specialized to deal with the increased pressure. For example, some fish have gas-filled swim bladders that help them control their buoyancy and balance in the water, such as tilapia, or to move between different depths as they migrate between seas and rivers, such as salmon

Organisms at the great depths:

At the great depths (greater than 2000 m), water pressure is very intense. Organisms that live in these environments often have compact body structures in addition to proteins and internal fluids that can withstand the high pressure. Also, some of these organisms do not have swim (air) bladders to ensure they do not collapse under this pressure, such as rays (which increase their body density to withstand the high pressure). Or they have a bladder that contains liquids instead of gases and rely on a large, oil-rich liver to increase their buoyancy and control depth.

Second: Bony and cartilaginous skeletons:

Bony fish or Osteichthyes (such as tilapia and mullet) are characterized by having a skeleton made of bones. It provides strong support for the body of fish and stabilizes the body under various pressures such as water movement or water pressure.

Cartilaginous fish or Chondrichthyes such as sharks and rays are a group of fish characterized by having a cartilaginous skeleton instead of a bony one. Cartilage is a more flexible and lighter tissue than bone, giving cartilaginous fish a flexibility that distinguishes them from bony fish.

Third: Cellular membranes

The cellular membranes of deep-water organisms are characterized by the presence of lipoproteins that promote membrane elasticity and prevent membrane collapse. These proteins minimize the impact of pressure on cellular membranes, to prevent cell damage and ensuring the continuation of vital functions.

Check your understanding

Why does living in the deep sea require specific physiological adaptations?

How do adaptations in cellular membranes help organisms withstand high water pressure?

1 – 8 The role of solutions and concentrations in the movement of water and the distribution of living organisms

Get ready

Have you ever wondered why the distribution of organisms in oceans and lakes is different?

Water in water bodies is not pure, but it is mixed with several substances that are dissolved or suspended in it. These substances directly affect the density of the water, leading to changes in water currents and the distribution of living organisms at different depths .

1 -Aqueous solutions

Solution: is a homogeneous mixture of a solvent and a solute. In an aqueous environment, water is usually the solvent, while the solute can be a chemical substance such as salts or other substances.

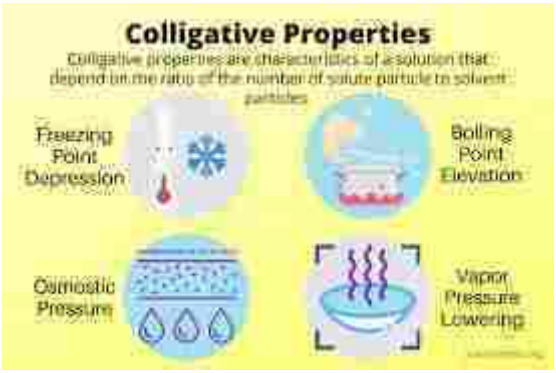
Concentration: is the amount of solute in a given volume of a solvent.

2 - The effect of concentration on the density of water:

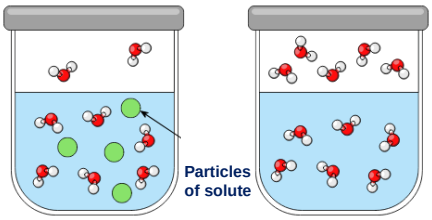
The higher the concentration of dissolved substances in water, the higher the density of water. These changes in density can lead to different movements of the water such as vertical currents that carry living organisms to different depths or to the surface

3 - The colligative properties of water

These are properties of a solution that depend on the number of solute particles, not its type. Colligative properties include vapor pressure, boiling point, freezing point, and osmotic pressure



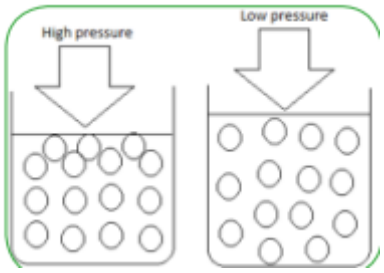
First: the vapor pressure of the liquid:



When a liquid and its vapour are in dynamic equilibrium, the liquid vapour formed above the surface of the liquid from evaporation exerts a pressure on the surface of the liquid called the vapour pressure of the liquid .

In **pure water**, the molecules on the surface of the water can break free and become vapour. The water molecules have attractive forces to each other, in addition to the attraction caused by the hydrogen bonds caused by the polarity of the water molecule. While in **solutions**, the water molecules have an additional attraction force with the solute molecules, making the water molecules less likely to evaporate. The attraction forces between solute molecules and water molecules are stronger than the attraction forces between water molecules and each other, so fewer water molecules can evaporate, and the vapor pressure of the liquid decreases. The decrease in the liquid vapor pressure of a solution is directly proportional to the number of solute molecules or ions in the solution.

Second: Boiling point

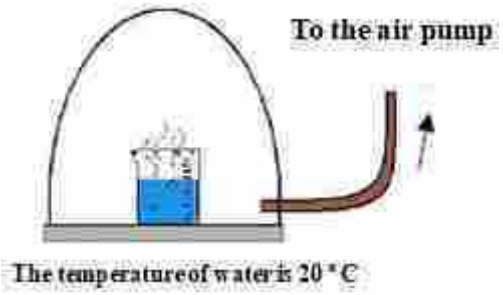


A liquid boils when its vapor pressure reaches the value of atmospheric air pressure at the surface of the liquid. Therefore, the boiling point of a pure liquid under normal atmospheric pressure is constant, so it is a property from which the purity of liquids can be inferred. The boiling point of a liquid varies if the air pressure at the surface of the liquid varies. The boiling point of a pure liquid increases as the air pressure acting on its surface increases.

The boiling point of a solution is higher than the boiling point of pure water at normal atmospheric pressure due to the bonding forces between the solute and solvent molecules, which increases the energy required to vaporize the liquid. The increase in the boiling point of a solution is directly proportional to the number of molecules or ions dissolved in the solution

Life applications

Can pure water boil at temperatures below 100° C?
What do you expect the boiling point of pure water to be in the following conditions?
1 - At the top of a high mountain?
2 - Inside a pressure cooker?



Investigative activity

Measure the boiling point of several solutions of different salts which have the same concentration, such as: Sodium chloride solution, sodium bicarbonate solution.

Third: Freezing point

The freezing point of the solution is always lower than the freezing point of pure water because the attraction forces between water molecules and solute molecules hinder the freezing process and

Life application:

Salt is sprinkled on roads in cold areas after rainfall so that the rainwater turns into a salt solution, and its freezing point is lower than the freezing point of water. Thus, the amount of ice formed on the road's decreases, which reduces the chances of accidents on the road.

activity

Measure the freezing point of several solutions that all have the same concentration of several different salts: Sodium chloride, calcium chloride, magnesium sulfate.

Distribution of living organisms in aquatic environments based on the concentration:

Some living organisms are adapted to certain concentrations of dissolved substances. For example, marine organisms that live at great depths are adapted to high water densities due to high concentrations of salts.

The distribution of organisms in aquatic environments is influenced by the following factors:

1 - Water type (Fresh versus salt water)

Living organisms are distributed based on the type of water. For example, freshwater fish cannot survive in saltwater, and vice versa.

2 - Osmotic adaptations

Living organisms need special adaptations according to the concentration of salts in their environment and the osmotic pressure of water. Marine organisms are adapted to high levels of salt, while freshwater organisms are adapted to avoid absorbing excess water.

3 - Concentration of nutrients and pollutants

The concentration of nutrients and pollutants affects the diversity of organisms. Resource-rich environments support greater diversity, while polluted environments may lead to lower diversity.

4 - Seasonal changes

Different seasons of the year affect the abundance of water, which affects the distribution of organisms. For example, certain types of organisms may move to new areas during dry or flood season.

5 - Water currents

Currents in water bodies affect the distribution of oxygen and nutrients, affecting the gathering and feeding areas of organisms**.**

Check your understanding (assessment)

1. How do concentrations of solutes affect the density of water?
2. What is the relationship between the concentration of dissolved substances and the movement of water currents?
3. How do chemical solutions in water affect the distribution of marine organisms?

1-9 Environmental balance and role of human in preserving the sustaining

Have you thought before how human activities affect the aquatic ecosystem could? Human activities play an important role in affecting the aquatic environment. Some of these activities are the overhunting and the activities that cause pollution.
Here we will explore how ecological balance maintains the health of marine environments, how human activities can lead to changes in this balance, and we will learn about strategies to protect and sustain these systems.

Importance of ecological balance in aquatic systems:

Ecological balance is a state of dynamic stability that occurs when organisms in an ecosystem interact in a way that maintains the continuity of life. This balance involves maintaining **the balance of nutrients, the diversity of organisms, and the flow of energy through food webs.**

1- Nutrient balance: In aquatic systems such as lakes and rivers, there must be a balance in the levels of nutrients such as nitrogen and phosphorus. These elements are essential for the growth of plants and algae that form the basis of the food chain. If the amounts of nutrients are excessive, as in the case of pollution from fertilizers, this can lead to abnormal algal blooms.

2. Balance between organisms: In aquatic systems, each species of organism interacts with others in multiple ways, whether as prey or predators. The presence of predatory fish in an aquatic ecosystem helps maintain a balance between the numbers of prey fish and other organisms. For example, in a marine environment containing different types of fish, if the numbers of predatory fish decline (due to overfishing, for example), the number of small fish may increase excessively, leading to unbalanced consumption of food resources and disruption of the ecosystem.

3. Energy flow through the food web: In an aquatic ecosystem, energy begins to flow from producers (such as algae and photosynthetic plants) to consumers (such as herbivorous and predatory fish). This natural flow of energy helps regulate the numbers of organisms at each level of the food chain. For example, if small fish (which feed on zooplankton) are consumed in large quantities by predatory fish, this leads to an increase in the numbers of zooplankton, which affects the growth of algae, thus causing the balance in the system to be out of balance.

Example of the ecological balance in aquatic systems:

Coral reefs and marine ecosystems: Coral reefs provide a habitat for many marine organisms. Predatory fish help maintain the balance of coral reefs by controlling the numbers of small organisms such as sea urchins, which can destroy reefs if their numbers increase unnaturally.

The effect of human activities on the aquatic life:

Pollution: Chemicals such as pesticides and heavy metals that are released into the water can affect the quality of the water and harm the health of living organisms.

Overfishing: Can lead to a decline in the numbers of some species and affect the ecological balance.

Environmental destruction: The destruction of natural habitats such as coral reefs and wetlands causes a loss of biodiversity.

The role of humans in maintaining the ecological balance:

Humans are considered a major factor influencing the changes that occur in the environment, whether positive or negative. Therefore, they must be responsible for maintaining the ecological balance and taking the necessary measures to reduce the negative effects.

These are some of the roles that humans can play to maintain the ecological balance:

1. Preserving natural resources: Humans must deal with natural resources such as water, forests, soil, and wildlife with caution. This can be done by using resources sustainably and avoiding pollution and excessive use of resources.

2. Environmental awareness and education: People must learn and understand the impact of their actions on the environment and share this knowledge with others. This can be achieved through environmental awareness and education activities, such as media campaigns, workshops, and education in schools.

3. Sustainable development: Maintaining environmental balance requires adopting sustainable development models that meet the needs of the current generation without compromising the ability of future generations to meet their needs. Man must strive to develop and use clean and sustainable technology, promote sustainable agriculture, and enhance sustainability in the industrial and urban sectors.

4. Participation in environmental policies: People must actively participate in making environmental decisions and in the development and implementation of environmental policies. This can be done by participating in public dialogues and forums, participating in environmental organizations, and pressuring governments to take strong action to protect the environment.

5. Switching to eco-friendly practices: People can take small steps in their daily lives to contribute to maintaining environmental balance, such as reducing water and energy consumption, sorting waste, and using public transportation or bicycles for transportation.

Search and inquiry (activities)

Developing a Plan to Protect Aquatic Ecosystems

- aim: Develop a plan to protect ecosystems from degradation.
- Tools: Worksheets, information about conservation strategies.
- Steps:

In this activity, you will learn how to protect aquatic ecosystems which represent an important part of our planet. You will first choose a specific aquatic ecosystem, such as a river, lake, or ocean. Next, you will review the challenges that this ecosystem faces, such as pollution, climate change, or excessive use of resources. Finally, you will design a comprehensive plan to protect this ecosystem, including specific actions and strategies that you can implement to protect it from degradation. You will use the worksheets provided to gather information and document your plan in detail.

Consider the following example:

The Nile River is the backbone of life in Egypt, with millions relying on its water for agriculture, drinking, and fishing. However, the river faces significant challenges that threaten its sustainability, including industrial pollution, overexploitation, and the effects of climate change. Decisive action must be taken to protect this vital ecosystem and ensure its sustainability for future generations.

Research Questions

1- Industrial pollution:

- What are the main sources of industrial pollution in the Nile River?
- How could industrial pollution affect the quality of water and aquatic life in the Nile River?
- What are the possible procedures that could be taken to reduce the industrial pollution in the Nile River?
- Are there successful examples from other countries in reducing the industrial pollution in their rivers? And how can be applied in Egypt?

2- Overexploitation of water resources:

How overexploitation of water affects the level of Nile River
What are the modern agricultural techniques that can be used to decrease the water consumption in agriculture?
What is the effect of dams and water diversion projects on the flow of the Nile River?
How can water consumption be regulated among different users (agriculture, industry, population) to ensure the sustainability of water resources?

3. Climate Change:

How does climate change affect the Nile River in terms of water flow, droughts, and floods?
What are the expected climate changes in Egypt over the coming decades, and how will they affect the Nile River?
What are the possible strategies for adapting to the effects of climate change on the Nile River?
How can technology be used to develop early warning systems for floods and droughts in the Nile River?

4. Ecosystem Protection:

What are the endangered animal and plant species in the Nile River due to current environmental challenges?
How can environmental awareness be raised among the local community to participate in Nile River protection efforts?
What are the current government policies for Nile River protection, and are they sufficient?
How can the local community and NGOs be involved in Nile River protection efforts?

Chapter Two : Atmosphere

LEARNING OUTCOMES:

After completing this chapter, the student will be able to:

1. **Explain the composition of the atmosphere and its main components and their effect on the earth's surface.**
2. **Distinguish between the different layers of the atmosphere and describe the characteristics of each layer.**
3. **Analyze the effect of physical factors in the atmosphere, such as temperature, pressure, humidity, solar radiation, and wind speed, on the distribution of organisms and climatic conditions.**
4. **Compare the effect of different physical factors on climate in various geographical areas.**
5. **Evaluate the effect of chemical reactions in the atmosphere such as ozone formation and air pollution on public health and the environment.**
6. **Explain how chemical reactions in the atmosphere affect air quality and climate change.**
7. **Integrates the knowledge gained to assess the practical effects of changes in the atmosphere on daily life and the environment.**
8. **.Propose practical** solutions to air pollution and climate change based on the information learned.

ISSUES INVOLVED

1. **Climate change**
2. **Air pollution**
3. **Resource sustainability**

2-1 Atmosphere, its layers and components

Get ready

What happens if a planet has no atmosphere?

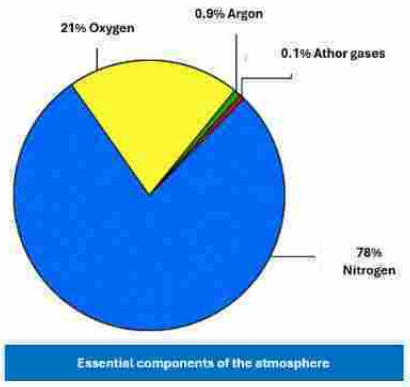
Mercury, the smallest planet of the solar system, does not have a gas envelope, so the surface of the planet absorbs the solar radiation that falls on it, so the temperature of the planet rises greatly, and when the sun is absent with its cycle, the radiation is emitted from the planet into space, and it cools very quickly because there is no gas envelope that retains the radiation.

The atmosphere is a layer of gases that surrounds the planet Earth and protects it from most of the radiation and objects coming from space and maintains the balance of temperatures on its surface. The atmosphere contains gaseous components that support the existence of life. Earth's gravity keeps the Earth's atmosphere in place. In this chapter, we will learn about the composition of the atmosphere, its main components, and the effect of these components on the sustainability of life on Earth.

Learn

The atmosphere is composed of a mixture of several gases, the most important of which are:

- **Nitrogen (N_2)**: represents about 78% of the volume of the atmosphere, and it is a largely inert gas that does not easily react with other gases and elements, and needs special conditions such as lightning or very high temperatures to react, so its oxides are very small in the air.
- **Oxygen** (O_2): represents about 21% of the volume of the atmosphere and is an essential gas in the respiration process of all living things. O_2 is chemically active. It is the active element in combustion, the respiration of living organisms, and many natural and industrial chemical reactions.
- **Argon** (Ar): an inert gas that makes up about 0.93% of the volume of the atmosphere.
- **Carbon dioxide** (CO_2): Makes up about 0.04% of the volume of the atmosphere and is essential for plant photosynthesis.
- **Water vapor (H_2O):** Its percentage varies from one place to another in the near layer of the atmosphere, and it plays an important role in weather and climate phenomena.
- **Ozone gas (O_3):** The ozone layer is found at an altitude of approximately 10 km - 55 km from The Earth's surface, and is characterized by its ability to absorb short-wave ultraviolet radiation, thus protecting living organisms on the surface of Earth from its destructive effect, while Ozone The Earth's surface is toxic and harmful to these organisms



Essential components of the atmosphere

Layers of the atmosphere:

The atmosphere is divided into several layers, each of have special characteristics, the most important of which are:

① Troposphere:

The layer closest to The Earth's surface, with a thickness of about 18 km at the equator and 8 km at the two poles. It is thicker at the equator due to the presence of hot convection currents that push gases upward.

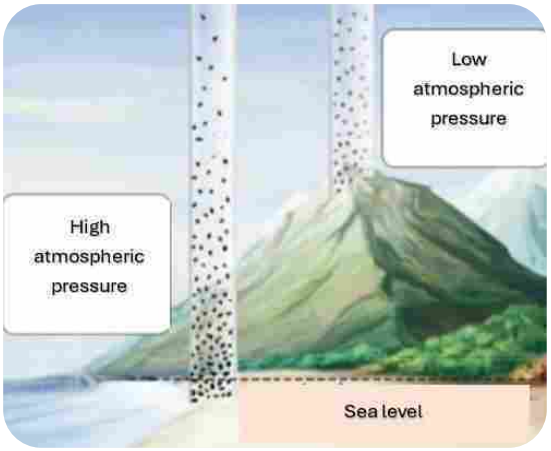
The air temperature decreases with height in that layer, reduced by one degree Celsius for every 176 m. This decrease in temperature is due to the decrease in atmospheric pressure with altitude, which leads to the expansion of the air, which requires energy from some of the kinetic energy of the air molecules.

In this layer, many weather phenomena related to weather and climate occur, such as cloud formation, rainfall, wind movement, etc .

The effect of atmospheric pressure on wind movement

Atmospheric pressure is the result of the weight of the column of air extending from a given point to the end of the atmosphere and affecting the unit area around it .

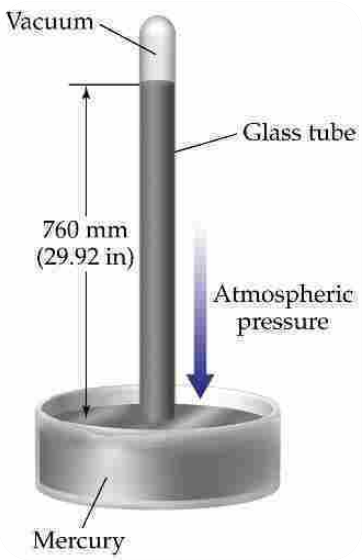
Atmospheric pressure varies from one point to another in the atmosphere, as the value of atmospheric pressure is affected by the height of the air column above the point. This difference in atmospheric pressure between two areas in the same horizontal plane leads to the movement of air from the area with high atmospheric pressure to the area with low atmospheric pressure .



On weather maps, lines are drawn connecting all places or points with equal atmospheric pressure called isobars, with low barometric pressure symbolized by the letter 'L' and high atmospheric pressure symbolized by the letter 'H'. The millibar is usually used as the unit of barometric pressure on meteorological maps.

Mercury barometer

A mercury barometer is used to measure atmospheric pressure.



Activity:

In the figure, a mercury barometer has a vertical height difference between the two mercury levels of 760 mm, discuss with your partner:

- Why is this height representative of atmospheric pressure?
- How can the barometer be used to determine the height of a mountain, for example

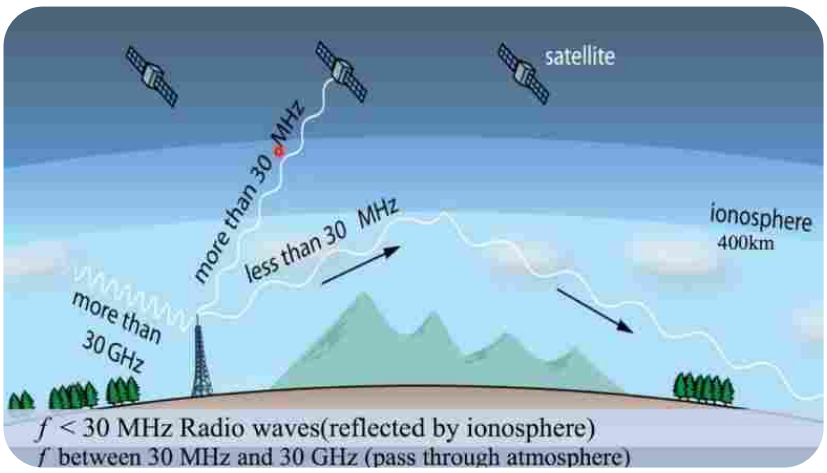
Standard (normal) atmospheric pressure:

The value of atmospheric pressure at sea level at 0 degrees Celsius is called the standard (normal) atmospheric pressure and is equal to 101300 N/m^2, which is equivalent to 1013 millibar, or 760 mm.Hg.

② Stratosphere:

The layer above the troposphere, its height up to 50 km above sea level, contains the ozone layer.

The temperature does not change through the stratosphere layer until an altitude of 20 km, then the temperature starts to rise as we go higher due to the presence of ozone gas in the upper part of the stratosphere. Air movement is horizontal, so this layer is preferred for airplane flights.



③ Mesosphere:

A layer about 30 km thick is the lowest layer of the atmosphere with the lowest temperature (-90 °C). Most meteors falling from space burn up as they pass through this layer, which protects the Earth from them.

④ Ionosphere

Extending approximately to 640 km above sea level, it is an electrically charged layer as a result of ionization of atmospheric atoms due to solar radiation, so it is used in long-distance radio communications due to its ability to reflect radio waves.

Research and investigation

Model of layers of the atmosphere

-aim: understanding the composition of the atmosphere through a visual model.

-Tools: Use foam to make a model of the layers of the atmosphere, considering the thickness of each layer.

-Steps:

1- Identify the main characteristics of each layer.

2- Describe how each layer affects life on Eart

Check your understanding

Choose the correct answer

(1) Which layer of the atmosphere contains the most Ozone?

Ⓐ ○ Troposphere
Ⓑ ○ Stratosphere
Ⓒ ○ Mesosphere
Ⓓ ○ Ionosphere

(2) Which layer of the atmosphere do most atmospheric phenomena such as rain and wind occur?

Ⓐ ○ Mesosphere
Ⓑ ○ Ionosphere
Ⓒ ○ Troposphere
Ⓓ ○ Stratosphere

Answer the following questions:

1 -What is the percentage of oxygen in the atmosphere?
Why is this percentage important?

2 -List the layers of the atmosphere in order from closest to Earth to farthest away.

3 -Explain how the ozone layer protects life on Earth

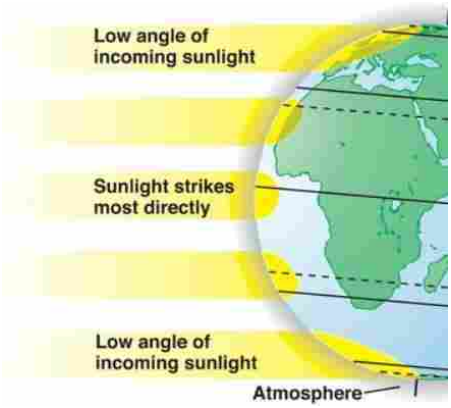
2.2 Physical Factors in the Atmosphere

The atmosphere is a dynamic system in which several physical factors interact to influence the weather and climate, and therefore the distribution of organisms in different climate zones. How can we explain why the weather changes from day to day? Or why some areas are warm and sunny while others are cold and dry? In this lesson, we learn how different physical factors such as temperature, pressure, humidity, solar radiation, and wind speed affect our daily lives and organisms.

The physical factors and their effect on the atmosphere:

◆ First: Heat

Heat is one of the most important climatic factors because it affects other factors such as atmospheric pressure, wind, humidity, condensation, and precipitation. The main source of heat and light on Earth is the sun. When the sun's rays reach the earth, the earth's surface of land and water heats up more, and then the heat is transferred to the gaseous atmosphere surrounding the earth. Its temperature begins to rise. The layers of the atmosphere closest to the Earth's surface are higher in temperature than the layers farther away. The sun's rays do not heat all areas of the Earth's surface at the same rate, and areas where the sun's rays fall vertically or nearly vertically receive more heat energy per unit area than those where the sun's rays are inclined.



◆ Measuring air temperature

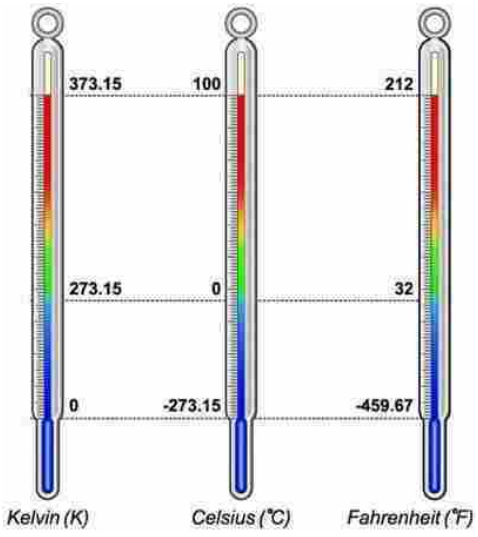
Meteorological organizations periodically measure the air temperature and compare it with the temperature in other regions, as well as with the temperatures recorded for previous years in the same climatic season.

These organizations use one of the following scales:

1- Celsius scale (t °C), which is the scale used in Egypt, for example.

2- Fahrenheit scale (t °F), which is the scale used in the USA for example.

3- Kelvin scale (T_K), the absolute temperature scale used in scientific fields.



Temperature	t_C	t_F	T_K
Freezing point of pure water (melting point of ice)	0 °C		
Boiling point of pure water	100 °C		

The relation between temperature scales

The relation between the absolute temperature scale T_K and the Celsius scale t_c:

$$T_K = t_c + 273$$

The relation between the Fahrenheit scale of temperature t_F and the Celsius scale t_c:

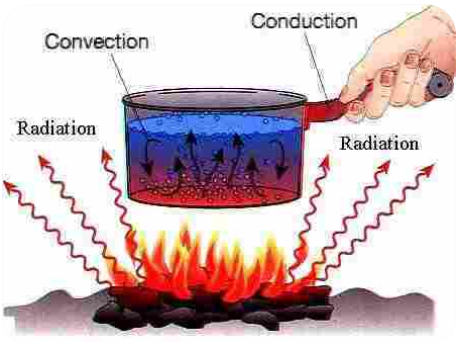
$$t_F = \left(\frac{9}{5} \times t_c\right) + 32$$

Exercise

Find the value of the freezing point of pure water and its boiling point on the Kelvin and Fahrenheit scales, and record them in the corresponding table

Mechanisms of heat transfer .

Heat is generally transferred in three ways :



1- Conduction: heat is transferred in a solid object or between two objects in contact, from one particle of the body in the region of higher temperature to neighboring particles in regions of lower temperature without being transferred. Some materials characterized by good thermal conductivity, such as metals, and others have low thermal conductivity, such as wood.

2- **Convection:** Heat is transferred through fluids by convection currents, where the higher-temperature parts of the fluid are less dense than the lower-temperature parts and the higher- density parts of the fluid begin to rise through it and are replaced by denser parts.

Have you ever seen a bird soar without flapping its wings? This is not just a beautiful sight; it is the result of birds utilizing what is known as thermal flight. Thermal flight is a technique a bird uses to stay in the air for long periods of time without constantly flapping its wings, saving energy. The bird floats above the rising hot air currents by convection and maintains its altitude

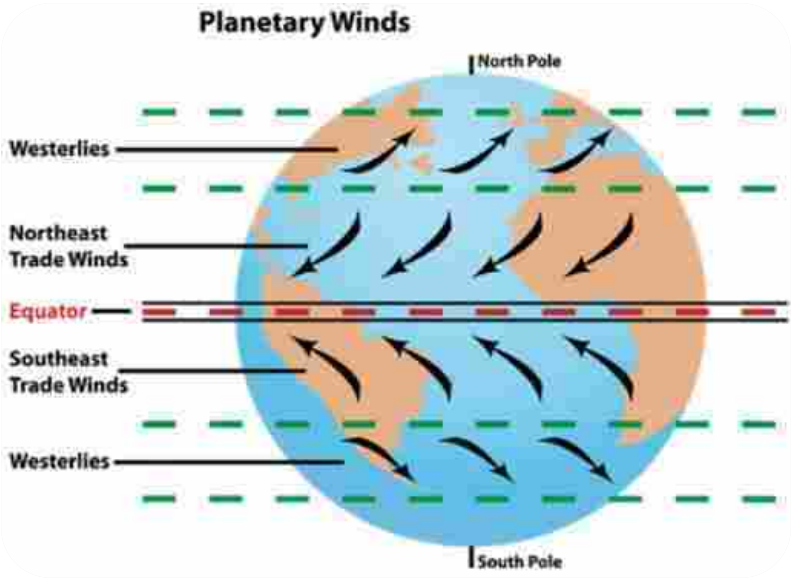
3- **Radiation** is the transfer of heat in the form of electromagnetic radiation. Thermal radiation propagates in all directions without the need for material medium. It can propagate in a vacuum, as well as through gases.

Research activity:

1- In cooperation with your colleague, draw a diagram showing the ways in which heat is transferred from the Sun to Earth's surface and then to the atmosphere.

Which material is the best from the thermal conductivity to use in making cooking utensils in order to save energy used for heating? Are there other factors that influence your choice of the best utensils?

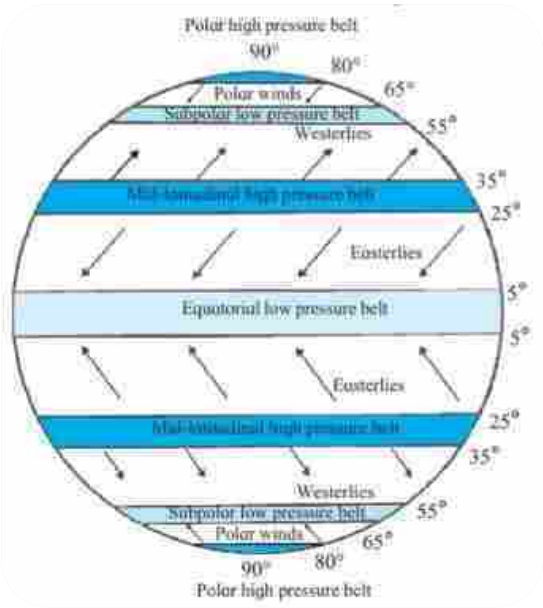
Second - Atmospheric Pressure:



Atmospheric pressure affects weather and climate. In low-pressure areas, the weather is usually windy and rainy, while in high-pressure areas, the weather is stable and not rainy.

The difference in atmospheric pressure causes wind to blow. At the equator, warm tropical air in the atmosphere rises upward, creating a low-pressure area. At the same time, the cooler, denser air above the Earth's surface moves toward the equator to replace the hot air.

Generally, from areas of high atmospheric pressure to areas of low atmospheric pressure. There are several wind systems at the Earth's surface, including the polar winds, which are dry and cold winds that blow from areas of high atmospheric pressure around the north and south poles to areas of low atmospheric pressure in the subpolar regions as shown in the figure.



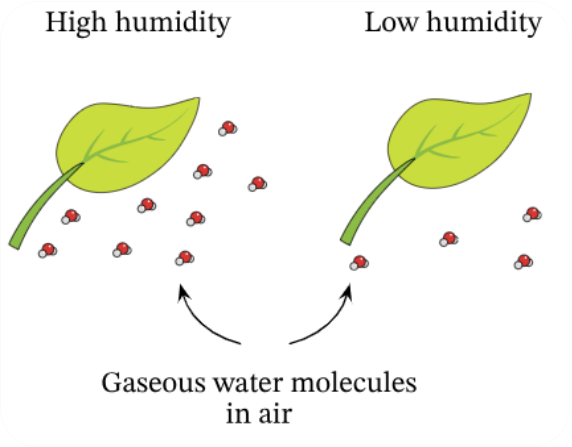
Atmospheric pressure affects the amount of oxygen available for breathing. In areas of low atmospheric pressure, such as high mountains, the oxygen levels available in the atmospheric air are lower, requiring adaptations from the organisms living in those areas such as increasing the number of red blood cells. Mountain climbers may suffer from burst blood capillaries in the nose due to the widening difference between the blood pressure inside and the low atmospheric pressure outside.

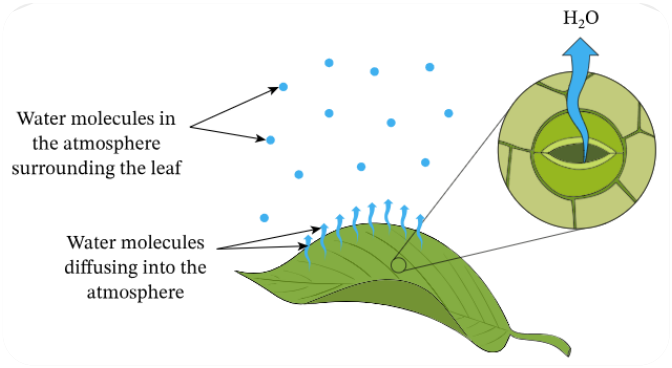
Third - Humidity:

Humidity is the amount of water vapor in the air. High humidity in the tropics affects cloud formation and precipitation, where rainfall is heavy and supports the growth of dense forests. It depends on temperature and atmospheric pressure. The higher the air temperature, the more water vapor it holds. When the air contains the maximum amount of water vapor it can hold at a given temperature and pressure, the air is said to be saturated with water vapor. The percentage of moisture in the air is measured with a hygrometer.

The effect of humidity on living organisms:

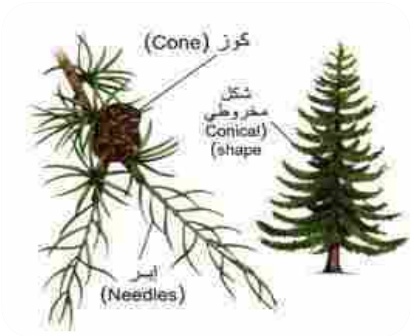
Some biological processes in living organisms are affected by the percentage of humidity in atmospheric air. As the relative humidity of the air surrounding the plant increases, the rate of transpiration decreases, which reduces the rate of lifting water and salts from the root to the leaves, and in animals, the rate of evaporation of sweat decreases, which reduces the efficiency of lowering their body

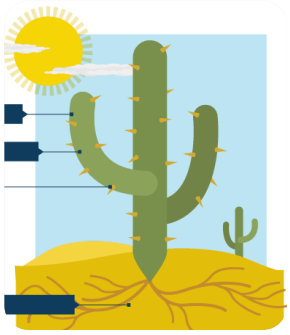




Fourth: Wind Speed:

The movement of air from areas of high atmospheric pressure to areas of low atmospheric pressure. Wind affects the distribution of heat and moisture in the atmosphere, which affects the climate in different regions. Strong winds can lead to significant changes in the weather. Wind Speed:





The effect of climate factors on living organisms

Climate affects the distribution, growth, behavior, and even the evolution of organisms over time. Organisms show remarkable abilities to adapt to extreme environmental changes.

1.Adaptation to Freezing:

The Wood Frog

The wood frog lives in cold northern regions like Alaska and Canada, where temperatures drop below freezing. In winter, the wood frog's body partially freezes—its heart stops beating, and it stops breathing. Surprisingly, the frog does not die in this state but instead enters a deep hibernation until spring arrives and the snow melts, allowing it to thaw and resume normal function.

The **wood frog** produces large amounts of glucose in its vital organs (heart, liver, brain) before freezing. The glucose acts as an antifreeze, preventing the formation of ice crystals in the cells and protecting them from damage. When temperatures rise in the spring, the ice melts, the heart starts beating again, and the frog's bodily functions resume without harm.

Antarctic Icefish:

This species of fish lives in the freezing waters of Antarctica, where water temperatures drop below zero—conditions that are deadly for most marine life. However, the icefish adapts to this frozen environment in remarkable ways by secreting special proteins in its blood known as antifreeze proteins. These proteins prevent the formation of ice crystals in the fish's blood and tissues, allowing it to survive in subzero temperatures.

The **Antarctic icefish** is one of the rare species whose blood does not contain hemoglobin (the pigment responsible for transporting oxygen in blood). Instead, it absorbs oxygen directly from the oxygen-rich waters of the extremely cold Antarctic.

2. Adaptation to High Temperatures:

Desert Lizards

Desert lizards live in extremely hot environments like deserts, where temperatures can reach dangerously high levels that are lethal for many other organisms. However, desert lizards have developed unique adaptations that allow them to survive in these harsh environments. These adaptations include behavioral strategies like seeking shade or burrowing during the hottest parts of the day, and physiological features such as efficient water retention and the ability to tolerate high body temperatures.

The **thorny devil lizard** from the Australian desert has small channels on the surface of its skin that help it collect moisture from the air or even from the sand. These channels direct the water toward its mouth, allowing the lizard to stay hydrated in an extremely dry environment.

Research and investigation

Activity 1: Measuring the effect of physical factors

aim: understanding the influence of physical factors on the atmosphere.

Tools: Thermometer, barometer, hygrometer, wind speed meter.

Steps:

1.Measure the temperature, pressure, humidity, and wind speed in your area over the course of an entire day.

2.Record the data and analyze how changes in these factors affect the local weather

Research and investigation

Activity 2: Analyze weather data

aim: Analyze weather data to understand the effect of physical factors.

Tools: Local or global weather data.

Steps:

1. Choose two different geographic regions (e.g., tropical, and polar).
2. Compare the temperature, pressure, humidity, and wind speed data between the two regions.
3. Analyze how these factors affect the climate in each region.

Check your understanding

(1) What is the relation between atmospheric pressure and temperature in the atmosphere?

(2) How do physical factors such as temperature, pressure, and humidity affect daily weather and long-term climate?

Research activity

Using various sources, prepare a presentation with a group of your classmates on climate change and its impact on local and global ecosystems. Can environmental changes be predicted and adapted to ensure the sustainability of life on Earth?

2-3: Chemical Reactions in the Atmosphere

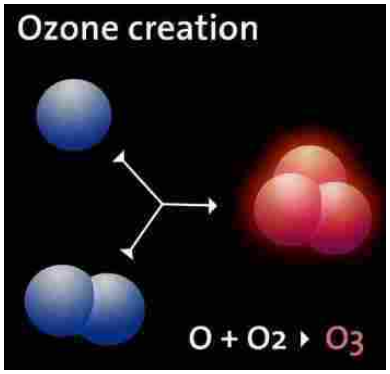
The atmosphere is not just a shield that protects the Earth, it is the scene of complex chemical reactions that play a crucial role in our daily lives. From the formation of ozone that protects the Earth from ultraviolet radiation to air pollution that threatens the health of humans and other living things. These chemical reactions in the atmosphere affect air quality, climate, and public health. In this lesson, we will learn about how these reactions occur and their effects on the environment and humans.

Chemical reactions in the atmosphere:

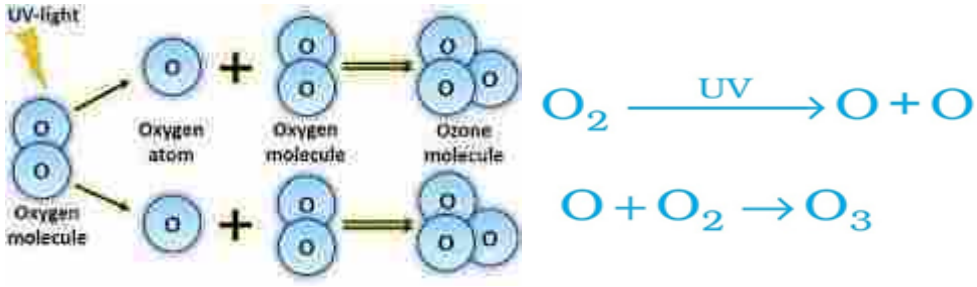
1. Ozone Formation :

The ozone molecule (O_3) consists of three oxygen atoms. Ozone is formed in the stratosphere of the atmosphere through the action of ultraviolet (UV) radiation from the sun on oxygen molecules (O_2) as follows:

1. Photo dissociation: UV radiation with a wavelength less than 240 nm breaks the covalent bond in the oxygen molecule (O_2), resulting in the production of two individual oxygen atoms (O).
2. Ozone Formation: An individual oxygen atom then reacts with an oxygen molecule (O_2) to form an ozone molecule (O_3).



Ozone formation



Ozone formation

The importance of ozone:

Ozone acts as a shield that protects the Earth from harmful ultraviolet radiation. Without this layer, life on Earth would be severely damaged by these rays.

The negative impact of ozone in the troposphere:

- **Air pollution:** Ozone gas in the troposphere forms part of smog. Smog is formed when ozone, nitrogen oxides (NO_x), sulfur dioxide (SO_2), and fine particles react in the presence of sunlight.

- **Health issues:** Ozone can cause health issues such as eye, nose, and throat irritation, breathing issues, asthma, and damage to the lungs.

- **Environmental effects:** Ozone can cause damage to plants and agricultural crops, affecting their growth and quality. It can also cause corrosion of materials such as plastics and rubber.

- **Greenhouse gas effect**: Ozone is one of the greenhouse gases in the troposphere that contribute to **the greenhouse effect.** This can lead to climate changes such as rising temperatures and changes in weather patterns.

2. Air Pollution

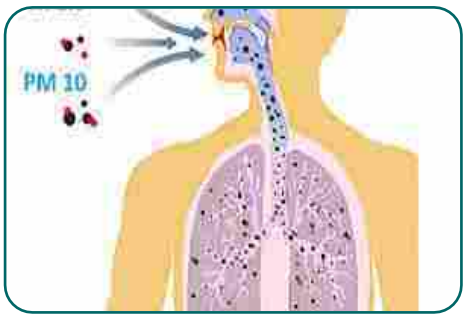
Air pollution can originate from **natural sources**, such as volcanoes and wildfires, or from **human activities**, such as factory smoke and vehicle emissions.

Air Pollution and Climate Change

Some air pollutants, like carbon dioxide (CO_2) and other greenhouse gases, contribute to global warming, leading to significant climate changes such as polar ice melting and rising sea levels.

Air Pollution and Human Health

1. **Respiratory Diseases:** Air pollution is linked to various respiratory diseases, including asthma, bronchitis, and allergies, as well as cardiovascular diseases like heart disease and stroke.
2. **Child Development:** Exposure to air pollution can negatively affect brain development and overall growth in children.
3. **Cancer Risk:** Some pollutants, such as benzene and arsenic, are associated with an increased risk of certain types of cancer.



Air Pollution and Ecosystems

Air pollution can lead to a loss of biodiversity in ecosystems.

1.effect on Plants: Tropospheric ozone can damage plant leaves, reducing their ability to perform photosynthesis. This negatively affects plant growth and productivity.

2. effect on Animals: Birds and insects are also affected by air pollution, influencing their behavior and reproduction. For example, declining bee populations due to air pollution impact the pollination rates of plants.

Strategies to Reduce Pollution

1. Public Transportation: Using public transport can help to reduce vehicle emissions.

2. improvement of Energy Efficiency: using Implementing energy-efficient technologies in homes and industries.

Example: Using **LED** bulbs and high-efficiency appliances.

3. Increasing Green Spaces: Planting trees and creating public gardens to help improve air quality.

Research and investigation (activities)

Activity 1: Analyzing the Impact of Pollution on the Environment
aim: Understand the effects of air pollution on ecosystems.
tools: Air quality data from your area, plant samples.
Steps:
1. Data Collection: Gather data on air pollution levels in your area over the course of a month.
2. Observation: Observe the impact of pollution on local plants (e.g., leaf damage or color changes).
3. Analysis: Analyze the relationship between pollution levels and changes in plant health.

Check your understanding

Choose the correct answer

(1) Which of the following chemical reactions is one of the main reasons for ozone formation in the stratosphere?

Ⓐ ○ **Reaction of nitrogen oxide with carbon dioxide.**
Ⓑ ○ **Reaction of oxygen with ultraviolet radiation.**
Ⓒ ○ **Reaction of water vapor with carbon.**
Ⓒ ○ **Reaction of ozone with sulfur oxide.**

(2) Which the chemical compound is responsible for the formation of smog in major cities due to the reaction between nitrogen oxides and hydrocarbons?

Ⓐ ○ **Ozone**
Ⓑ ○ **Nitrogen oxide**
Ⓒ ○ **Sulfur dioxide**
Ⓒ ○ **Carbon dioxide**

(3) Which compound is produced from the reaction of nitrogen oxide with ozone in the atmosphere, contributing to air pollution?

Ⓐ ○ **Nitrous oxide**
Ⓑ ○ **Nitric oxide**
Ⓒ ○ **Nitrogen dioxide**
Ⓒ ○ **Ozone**

2-4 Atmospheric changes and their impacts

Get ready

Changes in the atmosphere lead to many climatic changes. In recent times, an increase in summer temperatures has been observed year after year due to the global warming phenomenon, and atmospheric air pollution is the main cause of it. Therefore, some scientists predict that the decline of atmospheric air quality if it continues at the same rate in the future will require living organisms to live inside bubbles that protect them from pollution and radiation.

Learn

In this lesson, we will discuss how we can apply the knowledge we have learned about the atmosphere to evaluate these effects and develop sustainable solutions to environmental issues.

Changes in the atmosphere and their effects on everyday life:

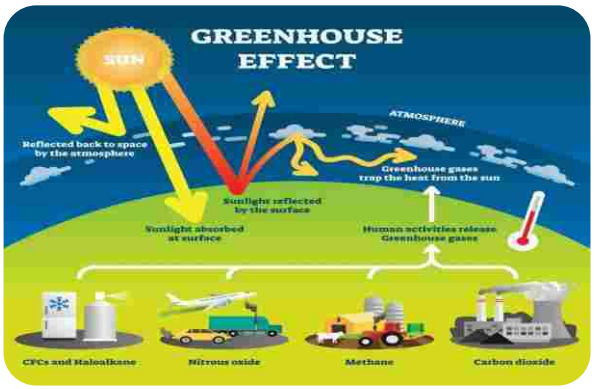
Understanding the atmosphere helps us realize the importance of protecting it. Constant changes in the composition of the atmosphere reduce its ability to maintain the Earth's surface at a temperature suitable for the life and activity of living organisms, and to protect the Earth from harmful solar radiation.

1.Climate change and its effects on ecosystems:

A global climate conference is held in which governments discuss the changes that occur as a result of the changing climate map and how to minimize climate change and prepare for it in the future, including these issues:

◆ **Global warming**

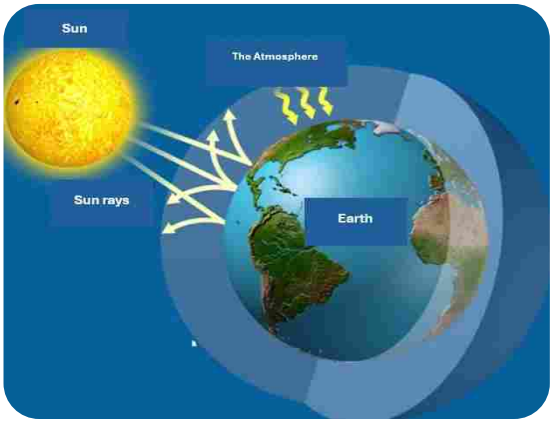
Global warming is defined as the continuous rise in the temperature of the air surrounding the Earth's surface. The burning of fossil fuels such as coal, oil, and gas results in greenhouse gas emissions that act like a cover around the earth, trapping heat in the atmosphere and raising temperatures. Global warming is causing major changes in climate, melting polar ice, and rising sea levels.



Greenhouse gases that cause global warming include carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and water vapor.

Increasing the percentage of greenhouse gases in the atmosphere works on the same basis as a greenhouse, as the atmosphere allows short-wavelength solar radiation to pass to the Earth, which in turn absorbs this radiation and then re-radiates it again as long-wavelength thermal radiation. Greenhouse gases significantly block the passage of this radiation to outer space, leading to a gradual rise in the Earth's surface temperature year after year.

Green house



Negative effects of global warming:

Melting ice: A large amount of fresh water is frozen in frozen rivers and icebergs at the poles, and with the increase in the earth's temperature, ice blocks separate from them repeatedly, which threatens the risk of flooding the coasts, which threatens an environmental disaster, the features of which are:

١- Extinction of polar creatures due to the damage to their natural habitat, which leads to a decrease in biodiversity and an imbalance in the ecological balance .

٢-The occurrence of severe climate changes, such as (hurricanes, floods, droughts, etc.)

Solutions to air pollution and climate change:

First: expand the use of renewable energy:

Changing to clean energy sources such as solar, wind, and hydropower can reduce greenhouse gas emissions.

Second: Planting:

Have you noticed that the Egyptian state is interested in the presence of green spaces and gardens in the construction of new cities?

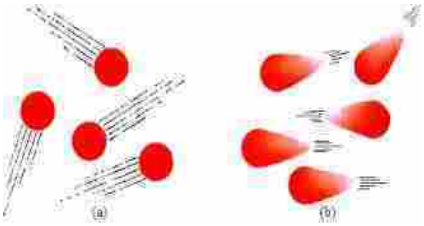
Do you know why?

The presence of a large number of trees helps increase the photosynthesis process carried out by plants, which has a key role in absorbing carbon dioxide gas, which is the most important cause of global warming. Therefore, planting is one of the most important ways to reduce global warming.

The role of trees in reducing temperatures

How does the Earth hold on to atmospheric gases?

Escape velocity



The molecules of each gas move at enormous speeds that depend on the mass of the gas molecule and the temperature. Naturally, this speed is greater for less massive molecules at higher temperatures.

For an object to escape the gravity of a planet, it needs to gain a certain speed called the escape velocity Ve (the speed of escape from the planet's gravitational field), which is a constant amount for every planet. The escape velocity from Earth's gravity is about 11.2 km/s.

Whether a planet holds a gas on its surface depends on the relationship between the effective velocity of the gas particles, v_{rms}, and the escape velocity from the planet's surface, v_e.

- If the effective velocity of the gas molecules ($v_{rms} < v_e$) is less than the escape velocity, the gas molecules cannot escape into space from the planet's gravity, and the planet retains the gas on its surface.
- If the effective velocity of the gas molecules is equal to or greater than the escape velocity from the planet's gravity ($v_{rms} \geq v_e$), the gas molecules can escape the planet's gravity into space. The gas becomes rare or non-existent on the surface of the planet. This is true for planets with low escape velocities, such as Mercury.

So now you can see why the Earth retains its gaseous envelope.

The effect of atmospheric change on living organisms

1- Change in temperatures

Changes in the atmosphere greatly affect the lives of organisms. This includes changes in temperatures, atmospheric pressure, humidity, and air pollution. Understanding how these changes affect daily life enables us to take effective steps to adapt to these changes. Temperature changes:

Temperatures directly affect the growth of many plants. For example, tomato is a plant that needs certain temperatures to grow well. Higher temperatures can negatively affect the production of some agricultural crops such as wheat. This is why some crops are classified as summer crops and others as winter crops.

2- Changes in humidity:

Some plants, such as tropical plants, need high humidity to grow, while desert plants grow better in low humidity.

3- Air pollution

Air pollution negatively affects the general health of humans and causes many diseases of the respiratory system.

Air pollution affects plants and animals, which affects wildlife, and may lead to the extinction of some species.

Research and investigation (activities)

Activity 1:

Develop projects or models for environmental solutions

aim: Apply scientific knowledge to develop practical solutions to environmental problems.

Tools: Environmental materials, scale models, design programs.

Steps:

1. Choose an environmental issue related to the atmosphere (e.g., air pollution).
2. Design a model or project that helps to solve this issue.
3. Present your model with a scientific explanation of how it works and its potential effect.

Activity 2:

Discuss real case studies

aim: Understanding real-world applications of technologies to reduce air pollution and climate change.

Tools: Scientific articles, environmental reports.

Steps:

1. Choose a case study related to a specific environmental issue.
2. Read the study and extract the main points.
3. Discuss in a group how the solutions were applied in this case and how they could be improved.

Activity 3: Field visit

Visit a weather station or environmental research center to understand how changes in the atmosphere are measured.

Check your understanding

(1) How do changes in the atmosphere affect everyday life?
(2) What are some possible solutions to climate change and air pollution?
(3) Why does Earth's gravity hold the atmosphere and not let go?

Integration of science (technology and environmental science):

Technology: How do new technologies contribute to reducing air pollution and improving quality of life?

Environmental science: How can we assess the environmental impact of human activities on the atmosphere and provide sustainable solutions?

Conclusion

Changes in the atmosphere have long-term effects on our lives and the planet as a whole. By understanding these changes and developing practical solutions, we can help protect the environment and ensure the sustainability of life for future generations.

Chapter Three : Soil

LEARNING OUTCOMES:

After completing this chapter, the student will be able to:

1. **Describe the composition of soil and its main elements such as minerals, organic matter, water, and air.**
2. **Explain the role of soil in supporting plants and maintaining the balance of the ecosystem.**
3. **Relate the different soil properties and their impact on plant health.**
4. **Explain the effect of acid rain on soil.**
5. **Enumerates soil measurements and explains conservation strategies.**
6. **Devise ways to develop soil conservation plans.**

ISSUES INVOLVED

1. **Climate change**
2. **Reducing pollution**
3. **Environmental conservation**
4. **Sustainability**

3-1: Soil composition and its importance in the ecosystem

Get ready

Why do plants grow well in certain soils and not in others? What makes soil so important for supporting plant life?

In this lesson, we will learn about the composition of soil, the elements that make up soil, how its properties affect the health of plants and its role in maintaining ecological balance.

Learn

The study of soil is a branch of environmental and agricultural sciences that focuses on understanding the properties of soil, its composition, and how it affects plants, animals, and the environment. Most plants get their nutrients from soil, which is the main source of food for humans, animals, and all living things, so most organisms depend on soil for their existence. Soil is a valuable resource that needs careful scientific management because it is easily depleted and destroyed. If we understand and manage soil properly, we will avoid destroying one of the essential components of our environment and food security.

Soil:

Soil is not just the clay under our feet; it is a complex system made up of several key components. Soil is the upper, loose surface layer that covers the earth's crust and is formed by the weathering and crumbling of all types of igneous, sedimentary, and metamorphic rocks of the earth's crust by the effect of different surface physical factors, and their interaction with various environmental factors.

Soil and its constituents

Soil formation:

Soils are formed continuously, but very slowly, through weathering processes that lead to the fragmentation and decomposition of rocks. Weathering occurs as a result of physical, chemical, or biological processes. These processes can be extremely slow, taking tens of thousands of years.

Physical weathering: It occurs as a result of the fragmentation of rocks by physical processes such as temperature changes and repeated freezing and thawing of water in rock cracks or by mechanical processes when rocks rub against each other during transportation by wind and water currents, and gravity also has a role in soil formation.

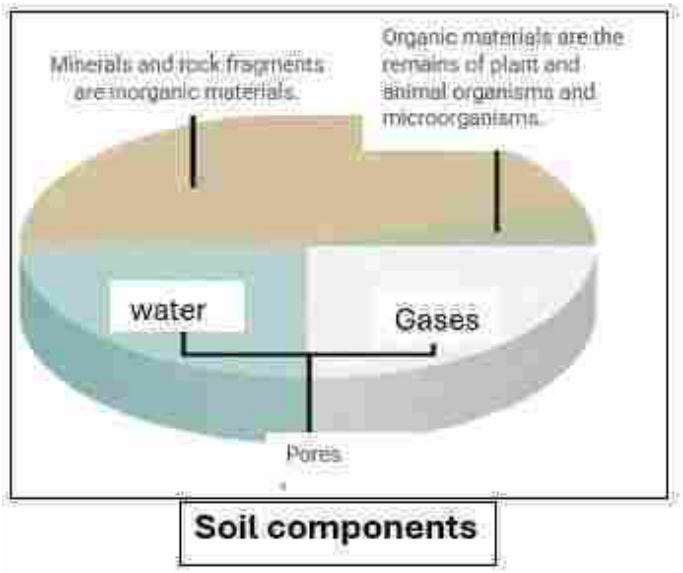
Chemical weathering: It occurs as a result of the decomposition of the mineral components of rocks in the presence of water through a change in their chemical composition, as the minerals react with air or other chemicals.

Biological weathering: The breakdown of rocks by living organisms, as animals that dig rocks help water and air enter the rock, and plant roots can grow into cracks in the rock, causing it to crack and then break apart.

Soil constituents: Soil is made up of several key components:

Minerals:

Minerals are the largest component of soil, mostly silicate minerals, and can be categorized into two main types, namely primary minerals, which are the result of the fragmentation of rocks by physical factors, and they are often irregular in shape and size and coarse. Secondary minerals that result from chemical and biological weathering processes of primary minerals, which are more stable minerals.



Organic matter:

A variety of plants and animals remains such as insects, earthworms, microorganisms such as fungi, bacteria, and other living and dead organisms that mix with the soil and are known as humus. This organic matter affects the chemical, ph**ysical and biological properties of the soil. The most important source of Organic matter is fertilizers and plant crop residues. Organic materials are not limited to that, but also include living components, such as: insects, earthworms, fungi, parasites, and other living organisms.**

Water:

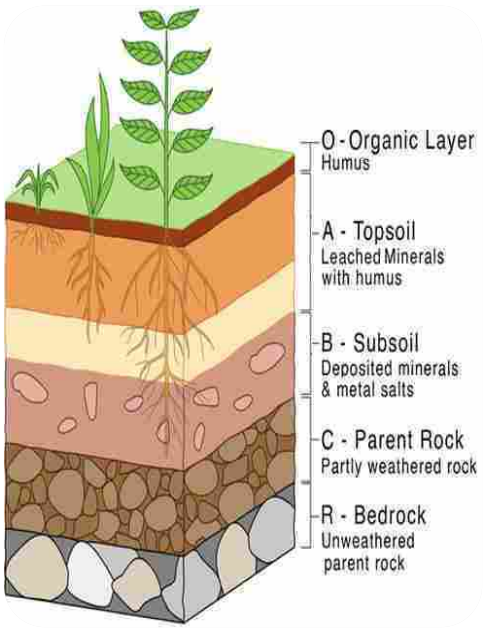
Water is found within the pores and is considered an essential part of soil components, as it is important for transporting nutrients to plants and soil organisms, as well as facilitating both biological and chemical decomposition. The soil retains water inside the pores and the ability of the soil to retain water varies depending on the size of the soil grains and temperature, clay soils are better at retaining water than sandy soils.

Gases:

The exchange of atmospheric gases occurs within the pores of the soil. These gases include oxygen, which is important for the respiration of plant roots and soil microorganisms, and carbon dioxide and nitrogen, which are important for the functions of organisms that help plant growth, such as nitrogen-fixing bacteria.

Soil profile:

The vertical section (profile) in the soil shows the different major horizons or zones of the soil whose thickness varies in different soil types depending on the type of bed rock from which the soil was formed, the influence of both organisms and climate factors and the time the bed rock has been exposed to weathering. Most different types of soil consist of three main horizon:



Soil profile showing the different layers or horizons.

-The soil surface or horizon (A): Consists mainly of plant remains that have accumulated on the soil surface and is rich in humus where nutrients, organic matter, and biological activity are present (i.e. Most plant roots, earthworms, insects, and microorganisms are active). Horizon A is usually darker in color than the other horizons due to organic matter .

-The subsoil surface or horizon (B): A clay-rich soil, horizon (B) is often less fertile, retains more moisture, is usually lighter in color, has a coarser texture, and has less biological activity than horizon (A).

The parent rock or horizon (C): Consists of cohesive or loosened rocky material from which the soils of horizon (A) and (B) were formed, and plant roots do not penetrate this layer.

Soil types and their physical properties :

There are many types of soils that differ in their properties depending on their composition and environment, such as clay, loamy, silt, sandy, humid, calcareous, red, and others. The main types of soils include:

1. Clay soil :

Clay soils are fine sediments, and the spaces between the sediments are very small, which makes them dense and poorly ventilated, and they have a high-water retention capacity, and therefore drainage is very poor due to the difficulty of water seepage from between the sediments, which makes them retain moisture for long periods of time. It is noted that the soil expands when wet and shrinks when dry, which leads to clay cracks.

Clay soil

2. Sandy soil :

Sandy soils consist of relatively large and coarse sandy deposits. There are large pores between the sediments, which makes them well ventilated, and their ability to retain water is low and water drains from them quickly, and they are quick to dry and unsuitable for agriculture without regular irrigation, and sandy soils are often exposed to denudation factors.

Sandy soil

3. Alluvial soils (silt soils):

-Alluvial soils are a mixture of clay, sand, and silt of fine size, but slightly larger than clay soil grains, moderately aerated and have a high water retention capacity, so they retain moisture well, but may become weak when waterlogged. Its drainage is average, retaining a reasonable amount of water but may become saturated in wet conditions. It has high fertility, making it ideal for cultivation.

Alluvial soils (silt soils)

The role of soil in the ecosystem:

Soil plays a vital and essential role in the ecosystem, contributing to many environmental processes that support life on Earth. Among the most important roles that soil plays in the ecosystem:

- **Supporting plant growth :**

-Soil is a source of nutrients, providing plants with essential nutrients such as nitrogen, phosphorus, and potassium that are necessary for growth.

-Soil acts as a means of stabilizing the roots, supporting the plant and preventing it from drifting or falling.

-Soil retains water and makes it available to plants as needed .

- **Regulating the water cycle:**

-Soil absorbs and stores rainwater, helping to provide water to plants during dry periods.

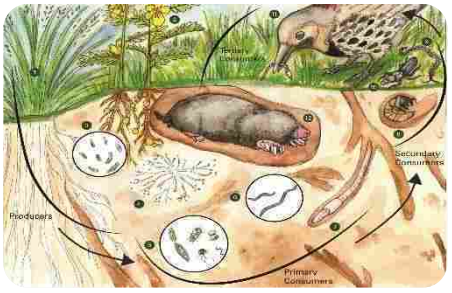
-As water seeps through soil layers, the soil acts as a natural filter that removes impurities and pollutants from the water before it reaches groundwater .

- **Nutrient cycling**

-Soil contains microorganisms such as bacteria and fungi that break down dead organic matter, turning it into nutrients that plants can use.

- **Supporting biodiversity and ecological balance**

-Soil provides a habitat for a wide range of organisms such as worms, insects, bacteria, and fungi. These organisms play vital roles in decomposing organic matter, fixing nitrogen, and aerating the soil.



-Soil supports plant biodiversity by providing a suitable environment for various plant species, which in turn supports wildlife.

- **Climate regulation**

-Healthy soils play an important role in mitigating climate change by sequestering carbon (absorbing carbon dioxide) and reducing greenhouse gases in the atmosphere.

-By reclaiming degraded soils and adopting soil conservation practices, the emission of greenhouse gases can be reduced.

-Soil plays a crucial role in regulating temperature. Soil absorbs and stores heat during the day, and slowly releases it at night, helping to smooth out rapid temperature changes.

- **Maintaining the structure of the Earth and preventing erosion**

-Plants that grow in the soil help stabilize it and prevent it from being eroded by wind or water.

-Healthy soil planted with plants helps prevent desertification and land degradation.

Conclusion

Soil is an essential element of life, supporting plants and contributing to many ecological processes. Soils differ in their properties, making each type of soil suitable for specific uses and crops based on its composition and its ability to retain water and drainage. Soil is not just a physical medium, but a living and dynamic system that contributes to the balance of ecosystems and the sustainability of life on Earth.

Research and investigation.

Activity 1: Analyze soil samples.

1. Collect soil samples from different areas (garden, farmland, roadside).

2. Analyze the samples to determine their composition in terms of mineral content, organic matter, moisture, and air.

3. Compare the samples in terms of their physical characteristics and their potential impact on plant growth through the following points :

- **Observe texture:**

-Touch each soil sample. Is it soft, coarse, sticky? Take notes .

- **Water retention test :**

-Place a small amount of soil in a strainer or over a cotton cloth in a funnel.

-Slowly pour a measured amount of water onto the soil, and observe how quickly the water seeps through the soil . Does it soak quickly **(like sandy soil),** or does it hold water for a long time **(like clay soil)**?

- **Drainage test:**

-Place an amount of each soil sample in a clear cup with identical holes at the bottom, then add an equal amount of water to each.

-Observe how quickly the water drains from each soil type .

-Compare the results and make notes about each property tested

Activity 2: Influence of soil on plant growth

1. Sow seeds of the same type of plant in different types of soil (sand, clay, loam).
2. Observe the growth of the plants over a period of two weeks, and record observations about plant height, leaf color, and germination percentage.
3. Conclude which soil type was more favorable for plant growth and why.

Check your understanding

Choose the correct answer

(1) Soils that are characterized by their ability to hold water, but are poorly aerated are:

Ⓐ ○ clay soils
Ⓑ ○ calcareous soils
Ⓒ ○ sandy soils
Ⓓ ○ loamy soils

(2) Which type of soil contains uniformly sized sediments, making it a poor water-holding soil?

Ⓐ ○ clay soils
Ⓑ ○ sandy soils
Ⓒ ○ Humic soils
Ⓓ ○ Alluvial soils

(3) Which soil zone contains the greatest amount of humus?

Ⓐ ○ Soil surface
Ⓑ ○ Subsoil surface
Ⓒ ○ Disintegrated rock
Ⓓ ○ Bedrock

3 – 2 :The effect of human practices on soil

Get ready

Soil is a vital part of the ecosystem, supporting plant growth and playing an important role in the nutrient cycle. However, various human activities, such as agriculture and industry, can degrade and destroy soil quality. In this lesson, we will learn about how these activities affect soil and the ways in which we can protect this vital resource.

effect of agricultural activities on soil quality :

Agricultural activities are one of the main reasons that affect soil quality, which can lead to:

1.Soil compaction:

The use of heavy agricultural machinery in agricultural areas such as tractors and large equipment excessively makes the soil highly compacted, reducing its ability to absorb water and air. This compaction leads to the formation of hard, petrified layers beneath the soil surface, which hinders the growth of plant roots and leads to poor agricultural yields.

Thus, plants grown in compacted soil have difficulty obtaining water and nutrients, resulting in unhealthy growth and poor crop yields. For example, in wheat fields that have been subjected to soil compaction, you may notice that the plants have become short and weak, with a decrease in the number of grains produced.

2 - Salination :

It means the increase of salt level in the soil. The soil is salted due to the accumulation of excess salts, usually visible to the naked eye on the surface of the soil. Groundwater containing salts is transported to the soil surface by capillary action, and when the water evaporates, the salts are deposited on the soil surface. In areas such as the Nile Valley in Egypt, the salinity of the soil increases due to flood irrigation or repeated irrigation of the soil over time. Most water contains some dissolved salts that seep into the soil, and because plants consume water and a very small amount of dissolved mineral salts, a large amount of salts in the soil begin to accumulate. The increased salinity of the soil makes it difficult for plants to absorb water, thus degrading the soil and the plant.

3- Lack of nutrients in the soil :

One of the biggest mistakes in agriculture is aiming to grow a single crop on the same soil and repeat this for years in a row, and although some economic benefits are obtained, they are temporary benefits, as this method causes the soil to be exhausted and lack some of the nutrients necessary for the plant to grow.

This method causes the soil to be exhausted and lacks some of the nutrients necessary for plant growth.

The effect of industrial activities on soil quality

Industrial activities contaminate the soil with chemicals and heavy metals, causing serious environmental Problems.

1 - Soil contamination with heavy metals:

In many Industrial areas around the world, high levels of lead and mercury have been found in the soil as a result of industrial waste drainage. Heavy metals such as lead and mercury are toxic to plants and animals, and plants that grow in soil contaminated with these metals may become toxic to humans and animals when consumed.

2 - Soil contamination with toxic chemicals:

Toxic chemicals seep into the soil from industrial areas, such as those around oil refineries and petrochemical factories that lead to soil pollution, such as the contamination of agricultural soil with “gasoline” liquid in areas surrounding oil refineries, which is a carcinogenic substance and its soil contamination may increase the risk of cancer in people living in these areas.

3 - Soil contamination with nitrate compounds:

In agricultural areas that rely heavily on manufactured nitrogen fertilizers to increase crop yields, such as some areas in the Egyptian Delta, excessive nitrate contamination of the soil is observed. Increased nitrate levels in the soil hinder the plants’ absorption of other nutrients, leading to poor growth. These chemical compounds not only contaminate the soil but may also seep into groundwater due to excessive irrigation or rainfall. Nitrate compounds are serious groundwater pollutants that make groundwater undrinkable. This contamination can lead to serious health issues, such as Blue Baby Syndrome, which affects infants who drink nitrate-contaminated water ..

Methods of soil conservation

In order to preserve the quality of the soil and protect it from degradation, you can adopt.

- Sustainable agricultural practices such as organic farming, which relies on the use of natural fertilizers and biopesticides, by converting agricultural waste and organic materials in garbage into organic fertilizer.
- Using crop rotation techniques, adopting a system of agricultural cycles and planting vegetation to prevent soil erosion.

- Use the "no-till farming" technique to maintain soil structure and reduce soil erosion. This technique contributes to maintaining the moisture level in the soil and improving its fertility in the long term.

Research and investigation

Research sustainable farming techniques applied in your governorate. Report on the environmental benefits of these techniques and how they contribute to maintain soil quality.

Check your understanding

First: Choose the correct answer from the following

(1) (1) The use of petrochemical compounds to kill insects leads to:

Ⓐ ○ **Blue Baby Syndrome**
Ⓑ ○ **liver cancer**
Ⓒ ○ **accumulation of salts in the soil**
Ⓓ ○ **increase of heavy metals in the soil**

(2) Growing a tomato crop in the same soil for several consecutive years leads to....

Ⓐ ○ **impede the absorption of nutrients by the plants**
Ⓑ ○ **soil compaction**
Ⓒ ○ **lack of nutrients in the soil**
Ⓓ ○ **increase the soil salinity**

Second: Answer the following:

(1) Explain how industrial activities can negatively affect soil quality. Provide a practical example to support your answer.
(2) Why is the excessive use of pesticides and chemical fertilizers harmful to the soil? How can we reduce this negative impact?
(3) Suggest one agricultural practice that can be used to protect the soil from degradation

Assessment

Review the concepts you learned in this lesson. Think about how you can apply these concepts in your daily life, especially if you live in an agricultural or industrial area. Write a brief report outlining steps you can take to protect the soil in your area

3-3 The effect of Acid Rain on Soil

Get ready

Acid rain is one of the negative environmental phenomena that significantly affects ecosystems, especially soil and plants. Acid rain is produced when pollutant gases in the atmosphere react with water vapor, resulting in the formation of acids that fall with rain.
In this lesson, we will explore how acid rain is formed and its impact on soil and plant health.

First: Acid Rain and Its effect on Soil

Acid rain is an environmental phenomenon that occurs when air pollutants such as sulfur oxides (SO_X) and nitrogen oxides (NO_X) react with water vapor in the atmosphere to form acids (sulfuric acid and nitric acid). These acids fall with rain, making the water more acidic and lowering the pH of rain to below 5.6.
When this rain falls on the soil, it reacts with its components, such as carbonate salts and minerals, leading to soil erosion and changes in its chemical composition.

Acid rain formation

Effects of Acid Rain on Soil:

1. **Soil Degradation:**

- **Erosion of Essential Minerals:** Acid rain can erode essential minerals in the soil, such as calcium and magnesium, reducing soil fertility.

- **Release of Toxic Metals:** Acid rain stimulates the deposition of toxic metals like aluminum in the soil. Trees and plants that absorb these metals may suffer from poisoning, this hinders plant growth and causes its death.

The impact of acid rain on tree roots

Example

In some forests, acid rain has acidified the soil and released dissolved aluminum, damaging tree roots and causing the death of many trees.

Effects on Plants:

Effect of acid rain on plants

- **Toxic Effects:** Acid rain can negatively impact plant health by eroding and poisoning roots with toxic metals.
- **Reducing Growth:** Lower nutrient levels in the soil can reduce plant growth and weaken overall plant health.
- **Decreasing Crop Yield:** Deterioration of soil quality due to acid rain can affect crops, result in lower agricultural productivity.
- **Crop Damage:** Acid rain can directly damage crops by reducing their ability to absorb essential nutrients.

Crops after acid rain

Additionally, acid rain negatively impacts the ecological balance, as changes in soil and plants disrupt the balance of ecosystems, including other plants and animals that rely on healthy soil.

Reducing the Effects of Acid Rain on Plants and Soil:

- Reducing Emissions: Improving fuel combustion technologies and adding purification devices to reduce sulfur and nitrogen oxide emissions.
- Using Alkaline Fertilizers: Alkaline fertilizers such as lime can be used to neutralize acids in the soil.
- Implementing Environmental Policies: Enforcing laws to regulate pollutant emissions.
- Raise Awareness: Promote environmental awareness about the impact of acid rain and the importance of preventive measures.

Investigation and Inquiry

(1) Conduct an experiment to measure the effect of diluted acid on a soil sample. Observe the changes that occur in the soil and compare them to a sample not exposed to acid.

(2) Collect soil samples from different areas (affected and unaffected by acid rain), analyze their chemical properties using soil analysis tools, and compare the results. Discuss the environmental impact of acid rain.

Check vour

Choose the correct answer

(1) What is the primary cause of acid rain?

Ⓐ ○ Evaporation of water from oceans
Ⓑ ○ Reaction of sulfur dioxide with water vapor
Ⓒ ○ Air pollution by plastic pollutants
Ⓓ ○ Accumulation of dust in the atmosphere

(2) What is the effect of acid rain on plant soil?

Ⓐ ○ Increased soil fertility
Ⓑ ○ Improved soil structure and enhanced plant growth
Ⓒ ○ Improved soil quality and increased nutrients
Ⓓ ○ Erosion of essential minerals in the soil and release of toxic metals

(3) Which of the following is a direct effect of acid rain on agricultural crops?

Ⓐ ○ Increasing agricultural yield
Ⓑ ○ Reducing crop quality and productivity
Ⓒ ○Enhancing healthy growth of crops
Ⓓ ○ Improving crop stability under changing environmental conditions

(4) Which of the following measures is preferred to address the effects of acid rain on soil?

Ⓐ ○ Adding large amounts of chemical fertilizers
Ⓑ ○ Using lime fertilizers to neutralize acids
Ⓒ ○ Increasing the use of pesticides
Ⓓ ○ Removing contaminated soil and discarding it

3-4 Soil measurements and strategies of its preservation:

Get ready

The soil plays a vital role in supporting life on our planet, and it is the base of agriculture and ecosystems. Preserving good soil needs a fine understanding of its properties and how to measure them. In this lesson we will identify how to measure the humidity, acidity, mineral structure of soil, and we will discuss the strategies of preservation of soil and improving its quality to guarantee its sustainability.

First: techniques of measuring the humidity, acidity, and mineral structure of the soil

Understanding of soil properties requires using fine measuring techniques.

Soil humidity:

It is an expression for the total amount of water found in the soil's fine pores or on its surface. Soil humidity is affected by environmental factors like raining, type of soil, type of plants in soil.

Soil humidity is considered as crucial indicator in cultivation as if the water content in the soil increases or decreases below a certain level, it negatively affects the plant. Climatic changes are considered the main responsible for the rate of humidity in soil and its change from time to time all over the year.

Measuring humidity:

The percentage of water measured in soil is measured by using (Moisture Meter) or by using techniques of weighing before or after dryness.

Factors effect on the soil humidity:

1- Salinity: as the salinity of soil increases, the percentage of water decreases in soil.

2- Size of particles: as the size of particles increases, the porosity increases (the percentage of pores and space to the size of soil sample), and permeability increase (easy movement of water between soil particles), and water percentage decreased.

3 - Consistency of particles size: the more soil particles become different in size,(mixture from sand , clay and silt for example), the less porosity, the lower the permeability and the higher the percentage of water in the soil.

4- Temperature: as the soil temperature increased, its humidity decreased.

5- Depth: as the depth increased, the humidity increased.

Consequences of increased humidity of the soil:

The increased humidity in the soil leads to the rot and death of its roots.

The plant roots need water, but it needs air also for respiration of its cells,

as the humidity in the soil increased, the air reaches the plant roots decreased,

the root cells died due to inability to respire. And,

the excess water provides suitable medium for growth of saprophytic bacteria and fungi, so it grows on dead roots and decays them.

Activity

Aim: Measuring the percentage of humidity
Tools: Pot containing a plant, Moisture Meter
Steps:
1- be sure that the metal rod of the device is clean and completely dry, and its reading at zero.
2- Insert the metal rod in soil near the roots of the plant, and be sure that it is not in contact with the bottom of the pot.
3- Determine the reading directly.
4- Compare the reading with the suitable rate in irrigation of t

Activity

Aim: Measuring the percentage of humidity of soil by using technique of weight.
Tools: Pot containing a sample of soil, digital balance, Bunsen flame, heating dish.
Steps:
1- By using the digital balance determine the mass of empty dish.
2- Put a sample of soil on the heating dish on the flame till the water evaporates from it completely.
3- By using the digital balance determine the mass of the dish and the soil together.
4- **Mass of soil = Mass of dish and soil – mass of the empty dish**
5- Irrigate the pot by amount of water.
6- By using the digital balance determine the mass of soil after adding water to it.
Use the relation:

$$\textbf{Percentage of humidity} = \frac{\text{Mass of wet soil} - \text{mass of dry soil}}{\text{mass of dry soil}} \times 100$$

Measuring the acidity (pH):

Acidity of soil can be measured by using a pH meter which determines the acidity or basicity (alkalinity) of the soil. PH is the main indicator for choosing the type of soil suitable for cultivating certain crops, as when the acidity of soil increases, it can be neutralized by using alkaline substances like lime.

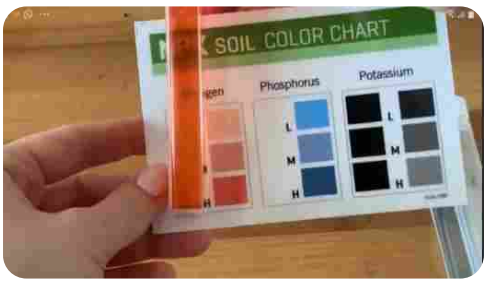
Activity

Aim: Measuring the acidity of soil.
Tools: Digital pH meter.
Steps:
1- Place the metal part in distilled water as in the figure, then dry it with a tissue to be sure it is clean and free from any previous residues that affect the reading of pH meter.
2- put the metal rod of the device in the soil that is needed to determine its pH without reaching the bottom.
3- Record the reading of pH device directly.
Observation and explanation:
pH 7 means neutral soil
pH higher than 7 means alkaline soil
pH less than 7 means acidic soil

Measuring the percentage of minerals in the soil:

Soil can be analyzed by using chemical methods to determine its components of essential elements like Nitrogen, Phosphorus, and Potassium (NPK). Soil analysis and measuring the percentage of essential elements (NPK) in it has a role in cultivation of plants as:
1- Potassium (K) is essential for healthy growth of plant and flower formation.
2- Phosphorus (P) helps strengthen plant roots.
3- Nitrogen (N) is essential for the greening of plant leaves.

Activity



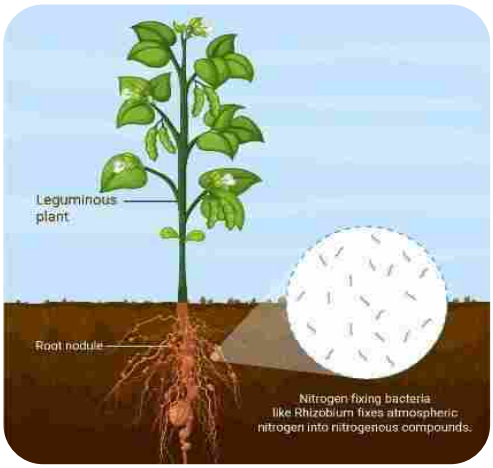
Aim: determine (NPK) content in the soil.
Tools: Soil sample, (NPK) indicators, test tubes.
Steps:
1- Put in an amount of distilled water in a test tube.
2- Put some of the soil in the tube, then shake it well and leave it to precipitate and form a solution on the soil.
3- Take equal amounts of solution then put them in new test tubes.
4- Add a capsule of (NPK) indicators for each element in a separate test tube and leave them for 10 minutes till the solutions become colored.
5- Compare the color of each solution by the color of each element indicator. The color of solution indicates the amount of saturation of the solution with this element which helps in taking the decision for the type of suitable soil fertilizer needed.

Second: Strategies of Preservation the soil and enhancing its quality:

For preservation of the soil and enhancing its quality, we must apply sustainable agriculture practices.

Plant cover: Cultivating plants that cover the soil help in preventing the corrosion or the soil dredging, and preserving humidity, as the root of the plant leads to coherence of the soil particles and prevent it`s dredging by the effect of wind and rains. The plants especially the trees act as windbreaks protect the soil from desertification

Crops rotation: Cultivating different crops in the same place along the seasons helps in keeping soil fertility and decreases the dependence on chemical fertilizers. It is known that legumes plants increase soil fertility and compensation what it lost from nutrients as it hosts inside their roots nodular bacteria that fixes the nitrogen in air and converting it into nitrogenous compounds used by the plants in manufacturing proteins.



Adding organic substances: Enhancing quality of soil can be achieved by adding organic fertilizers (Composting) which enhances fertility of soil and improve its structure.

Third: Applications of techniques of measuring the soil quality and developing plans for its preservation:

After measuring the properties of soil, we can develop plans to preserve the soil according to these measures. These plans may include adjusting soil acidity, improving drainage, or adding organic matter.

Example:

If the soil measures show that the level of humidity is low, steps can be taken to enhance the drainage and use supplementary irrigation to ensure the soil stays humid enough to support plant growth

Research and investigation

1- Collect a sample of soil from different places (garden, farm, uncultivated land) and use the devices of measuring humidity and pH to analyze them. Then compare the results and discuss the differences between different samples.

2-Develop a plan for the environmental factors and agricultural sustainable practices on the quality of soil in your area depending on the measurements you made.

Check your understanding

1- Explain how to measure the soil humidity and its acidity. Why are these measurements Considered important for maintaining soil quality?
2- How can strategies of plant cover and crops rotation help in preserving the soil? give applied examples.
3- Put a plan to enhance the quality of soil in a field that suffers from decrease of soil fertility. Mention the steps will be taken according to measures you took.

Evaluation:

After studying soil measurements and strategies to preserve it, think about how to apply this knowledge in your daily life, or in your community. Are there are ways you can participate in contribution of soil quality?
Write a report illustrates the steps that could be taken to do that

The role of science in environmental sustainability

LEARNING OUTCOMES:

By the end of chapter, the student will be able to:

1. **Explain the concept of sustainability and the importance of preserving the environment for future generations.**
2. **Analyze how human activities affect the sustainability of natural resources.**
3. **Evaluate environmental protection strategies, such as waste minimization and recycling.**
4. **Analyze the effect of chemical pollutants on the environment and the health of living organisms.**
5. **Explain how to measure pollution levels and identify pollution sources.**
6. **Evaluate chemical solutions to treat pollutants in the environment.**
7. **Explain the importance of biodiversity in maintaining the balance of ecosystems.**
8. **Analyze the effect of environmental changes on different species.**
9. **Evaluate strategies to protect endangered species.**

ISSUES INVOLVED

1. **Climate change**
2. **Reducing pollution**
3. **Conservation of environment**
4. **Sustainability**

4-1: The concept of sustainability and the role of the environment

Get ready

The concept of sustainability has become more important in our time, as the survival of future generations depends on our ability to conserve natural resources and manage human activities in a way that maintains ecological balance. In this lesson, we will learn about the concept of sustainability, its importance, and the impact of human activities on natural resources.

◆ The concept of sustainability

Sustainability: It means using natural resources in a way that enables current generations to meet their needs without affecting the ability of future generations to meet their needs. In other words, it is striking a balance between our needs today and preserving resources and the environment for future generations. This includes preserving biodiversity, minimizing the use of non-renewable resources, and protecting ecosystems.

First: The importance of sustainability and preserving the environment for future generations:

1. **Protecting natural resources**: Resources such as water, soil, forests, and minerals are limited. Using these resources excessively or unsustainably can lead to their depletion. Through sustainability, we can ensure that these resources are available for future generations.

2. **Protecting biodiversity:** Human activities such as deforestation, pollution, and overfishing lead to the loss of many animal and plant species. Conservation contributes to the protection of biodiversity, which is the foundation of an ecosystem and its health.

3. **Fighting climate change:** Climate change due to greenhouse gas emissions can have serious impacts on the environment. Sustainability includes efforts to reduce emissions and adapt to the effects of climate change, helping to protect the environment for future generations.

4. **Improving the quality of life:** Sustainability is not only about conserving resources, but also about improving the quality of life. By adopting sustainable practices, we can improve air and water quality, reduce pollution, and thereby enhance the health and well-being of communities.

5. **Promoting social justice:** Sustainability also supports the concept of social justice, by making sure that resources are distributed fairly and that communities that are less vulnerable to environmental impact are adequately protected.

6 . **effect on future generations:** A commitment to sustainability reflects respect for future generations and ensures that they have the opportunity to enjoy a clean and healthy environment.

Example

Using solar energy as an alternative to fossil fuels
An example of resource sustainability, as it reduces dependence on non-renewable resources and saves the environment from pollution.
By recognizing the importance of sustainability and applying it in our daily lives, we can work together to ensure that the Earth remains a viable place for future generations to live

Second: The effect of human activities on the sustainability of natural resources
Human activities have a significant impact on the sustainability of natural resources, depending on how we use and manage these resources. Some of these impacts include:

a) Depletion of natural resources
Minerals and energy: The extraction of minerals such as gold and copper, and fossil fuels such as coal and oil, is intensive, leading to the depletion of these natural resources. Over time, these resources may become scarce or inaccessible.

Water: Pollution of rivers and lakes and excessive water use in agriculture, industry, and domestic consumption lead to the depletion of water sources, affecting the availability of fresh water.

The effect of natural resource depletion on organisms and ecosystems

1. The impact of water depletion

The depletion of water resources, whether from rivers, lakes, or groundwater, greatly affects the organisms that depend on these sources. Freshwater shortages threaten the lives of organisms living in these environments, and lead to the extinction of some species as a result of habitat loss. In addition, water shortages can affect agricultural production, threatening the food security of organisms, including humans

2. Impact of deforestation

Deforestation, whether for agriculture or timber, leads to the loss of natural habitats for millions of animal and plant species. The destruction of forests leads to the loss of biodiversity, as many organisms rely on forests as a source of food and shelter. In addition, deforestation leads to changes in local and global climate, increasing environmental challenges for organisms.

3. Impact of soil depletion

The intensive and unsustainable use of soil in agriculture leads to its degradation and loss of fertility. This affects the productivity of the land and reduces the quantity and quality of food available to living organisms. In addition, soil degradation leads to desertification, which is the process of turning fertile land into barren land, reducing the land's ability to support life.

4. Impact of mineral resource depletion

Excessive extraction of minerals and other natural resources destroys land and impacts surrounding ecosystems. Mining activities, for example, can pollute water and soil, affecting the health of organisms that depend on these resources.

5. Impact of ocean depletion

Overexploitation of marine resources, such as overfishing and pollution, threatens the lives of marine organisms and leads to the collapse of ocean ecosystems. Declining populations of fish and other marine organisms due to depletion affect the marine food chain, putting many species at risk of extinction.

b) Environmental pollution

Air: Emissions from factories, transportation, and industrial activities release toxic gases and fine particulate matter into the air, leading to air pollution and climate change.

Water: The discharge of industrial waste and untreated sewage into water bodies causes water pollution, affecting aquatic life and human health.

Soil: The intensive use of soil in agriculture without considering the rest cycle of the soil affects its fertility and causes erosion. The use of fertilizers and pesticides can also lead to soil contamination, affecting its ability to support plants and future agricultural activities.

c) Destruction of natural habitats

Deforestation: removing and deforestation for agricultural or industrial purposes destroys natural habitats, leading to loss of biodiversity and increasing carbon dioxide emissions.

Deforestation

Urbanization: Construction and land development affects natural habitats and leads to soil erosion and habitat destruction.

d) Climate change

Human activities such as burning fossil fuels and deforestation increase the concentration of greenhouse gases in the atmosphere, leading to climate change and rising global temperatures. This climate change affects weather patterns, causes the melting of ice in Polar Regions, and leads to rising water levels in the seas, threatening coastal cities and biodiversity.

e) Loss of biodiversity

Overfishing: Overfishing of terrestrial and marine animals threatens the survival of many species and leads to an ecological imbalance as it leads to the disappearance of certain species of fish, threatening marine sustainability.

Habitat destruction: The destruction of natural habitats, such as forests and wetlands, reduces the habitats available to organisms, contributing to the loss of biodiversity.

Third: Environmental protection strategies:

To minimize these impacts, it is necessary to adopt sustainable practices such as

- **Renewable energy**: Switching to use renewable energy sources such as the sun and wind to reduce dependence on fossil fuels.
- **Protecting natural habitats**: Create natural protectorates and preserve natural habitats to protect species and preserve biodiversity.
- **Waste minimization**: Reducing the consumption of materials, reusing products, and looking for eco-friendly alternatives can reduce the amount of waste that is produced.

Recycling

- **Recycling**: Converting waste into reusable materials helps reduce pressure on natural resources and minimize environmental pollution.

Example

Recycling paper can reduce the need to cut down trees, which helps preserve forests and natural resources.
By implementing these practices, we can minimize the negative impacts of human activities and promote the sustainability of natural resources for future

Search and investigation

1. Research in the local community into recycling initiatives and how you can get involved; identify what kinds of waste can be recycled and how these initiatives can contribute to sustainability.
2. Develop an environmental protection plan for your school or home that includes reducing energy consumption, recycling, and raising awareness about the importance of conserving natural resources.

Check your understanding

Choose the correct answer

(1) What is the concept of sustainable development?

Ⓐ ○ Meeting the needs of current generations without considering the needs of future generations

Ⓑ ○ Excessive use of resources without regarding the environmental impacts

Ⓒ ○ Meeting the needs of current generations without compromising the ability of future generations to meet their needs

Ⓓ ○ Achieving rapid economic growth without regard to environmental consequences

(2) What is the main objective of developing and utilizing renewable energy sources?

Ⓐ ○ Increasing daily energy consumption

Ⓑ ○ Reduce dependence on fossil fuels and minimize the effects of climate change

Ⓒ ○ Enhance greenhouse gas emissions

Ⓓ ○ Improving the quality of fossil fuels

(3) Which of the following is considered a sustainable practice in agriculture

Ⓐ ○ Using fertilizers and pesticides in large quantities

Ⓑ ○ Growing the same crop in the same soil every season

Ⓒ ○ Using organic farming techniques and crop rotation

Ⓓ ○ Deforestation to expand agricultural land

(4) What is the goal of environmental protection within the concept of sustainable development?

Ⓐ ○ Stopping all human activities

Ⓑ ○ Preserving and protecting ecosystems to ensure the continuity and balance of life

Ⓒ ○ Increase environmental pollution to accelerate economic growth

Ⓓ ○ Reducing green spaces and increasing urbanization

4-2: The Effect of Pollutants on the Environment and Human Health

Get ready

In this lesson, we will learn how these pollutants affect the environment and human health, how to measure pollution levels, identify sources of pollution, and explore chemical solutions to address these pollutants.

First: The effect of chemical pollutants on the environment and the health of living organisms

Chemical pollutants: Toxic substances that can enter the environment and cause damage. They include:

- **Pesticides:** Chemicals used to control insects and the diseases they cause, such as dieldrin and chlordane.
- **Heavy metals:** Lead, mercury, and cadmium, which accumulate in the environment and in the cells of living organisms.
- **Volatile organic compounds:** Such as benzene, formaldehyde, and chloroform, which can vaporize into the air and pollute it.

Example: Mercury is a chemical pollutant that can accumulate in fish and be passed on to humans through the food chain, leading to serious poisoning that affects the nervous system.

The effect of pollutants on the environment:

- **Water pollution:**
  Example: Pesticides leaking from farms into waterways can kill fish and aquatic animals.
- **Soil pollution:**
  Example: The accumulation of heavy metals such as lead and mercury in the soil as a result of industrial waste or the use of fossil fuels can affect plant growth and make the soil unfit for agriculture.
- **Air pollution:**
  Example: Emissions from factories and cars, such as nitrogen oxides and fine particulate matter, can contribute to smog that affects the health of plants and animals.

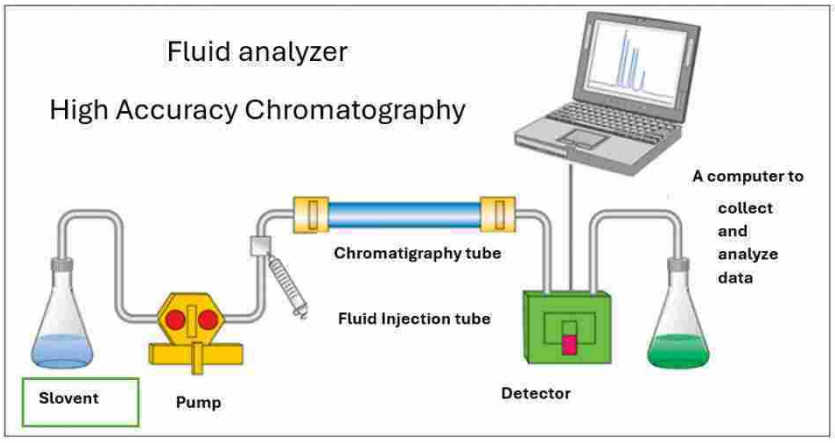
Effects of pollutants on human health:

- **Respiratory diseases:**
  Example: Inhaling air contaminated with ozone or particulate matter can lead to respiratory diseases such as asthma, bronchitis, and pneumonia.
- **Nervous system disorders:**
  Example: Exposure to heavy metals such as mercury and lead can affect the central nervous system, leading to neurological disorders.
- **Chronic diseases such as cancer:**
  Example: Exposure to toxic chemicals such as benzene and formaldehyde can increase the risk of cancer.

Second: How to measure pollution levels and identify pollution sources

Chemical analysis is a process used to determine the concentration of pollutants in water, air, and soil. Various techniques are used for this purpose, including

A. Water analysis:



Analytical techniques:

1. Chromatography: Used to separate and analyze organic compounds such as pesticides.

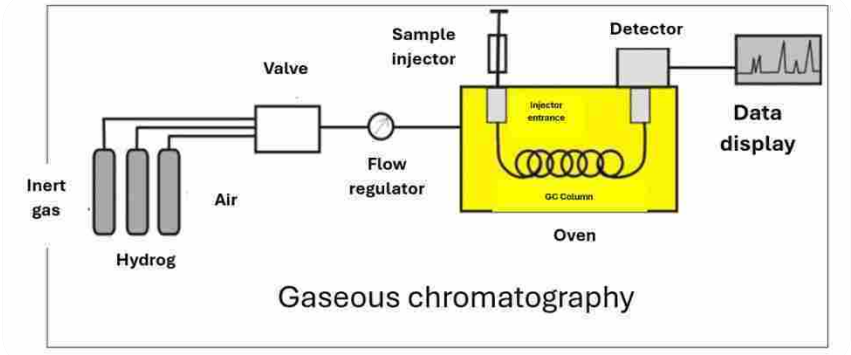
2. Spectroscopy: Used to identify heavy metals such as lead and mercury. For example, atomic absorption spectroscopy can be used to measure the concentration of mercury in water samples.

B. Air analysis:

- Analytical techniques:

1. UV spectroscopy: Used to measure oxides of nitrogen and ozone in the air. For example, nitric oxide and ozone concentrations can be measured using spectrometers.

1. **Gas chromatography:** Used to analyze volatile organic compounds such as benzene and formaldehyde. Air samples are taken and analyzed to determine the concentrations of these compounds



C. Soil analysis:

- Analytical techniques:

1. Wet chemical analysis: Used to extract and measure heavy metals such as lead and cadmium from soil samples.

2. Spectroscopy: To determine the concentrations of heavy metals in the soil.

Third: Chemical solutions to treat pollutants in the environment

1. Chemical treatment of water

Using activated carbon:

- Activated carbon is a substance that has a high ability to absorb organic matter and chemical contaminants. When water is passed through filters containing activated carbon, the contaminants bind to the carbon and are removed from the water.

Example: In drinking water treatment plants, activated carbon can be used to remove chemicals such as benzene and chloroform from the water.

Use of ozone:

- Ozone is a powerful oxidizing gas that can break down many organic and inorganic contaminants in water. Ozone reacts with pollutants to form harmless substances.

Example: In industrial wastewater treatment, ozone can be used to break down toxic organic compounds and remove unpleasant odors.

2. Biological treatment:

The use of microorganisms:

- Biological treatment is based on the use of bacteria, fungi, and other microbes to break down organic pollutants and convert them into less harmful or harmless substances.

wastewater treatment plant

Example

In wastewater treatment, special bacteria are used to break down organic matter into simple substances such as water and carbon dioxide.

3. Recycling and waste management:

Chemical waste recycling:

- **Chemical waste recycling involves collecting chemical waste, treating it, and reusing it or converting it into new products.**

Example

Example: In the electronics industry, e-waste is collected and processed to re-extract valuable metals such as gold and silver.

Medical waste disposal

- **Waste management involves storing waste safely, treating it properly, and avoiding disposing of it in ways that pollute the environment.**

Example

Example: In industrial facilities, special tanks are used to store chemical waste and dispose of it in safe ways such as thermal decomposition or chemical decomposition.

Research and investigation

First:

Conduct a simple experiment to measure the level of water pollution using chemical reagents and compare the results with the permissible pollution levels.

Steps:

Collect water samples from the source you wish to test. Make sure to use clean, covered bottles to avoid contamination - Prepare the reagents - Perform the reagent test

Phosphate Test

1. Add a certain amount of reagent to a test tube containing the water sample.
2. Mix the solution well and let it sit for a few minutes according to the reagent's instructions.
3. Compare the resulting color with the color scale provided with the reagent to determine the level of phosphate.

Chlorine testing

1. Use chlorine test strips that change color when exposed to chlorine.
2. Dip the test strip into the water sample and follow the instructions to read the results.
3. Record the results for each test, such as the concentration of phosphate or chlorine in the different samples

Check your understanding

Choose the correct answer

(1)) What is the main effect of lead exposure on human health?

Ⓐ ○ Increased physical ability
Ⓑ ○ Development of nervous system issues
Ⓒ ○ Improved bone health
Ⓓ ○ Reduced cancer incidence

(2) What is the most common purpose for using activated carbon in water treatment?

Ⓐ ○ Neutralizing acids
Ⓑ ○ Removing organic matter and chemical contaminants
Ⓒ ○ Adding nutrient minerals
Ⓓ ○ Sterilizing water using ultraviolet light

(3) What is the main source of phosphate that can cause water pollution in agricultural areas?

Ⓐ ○ Organic solvents
Ⓑ ○ Pesticides
Ⓒ ○ Agricultural fertilizers
Ⓓ ○ Industrial waste

Conclusion:

By the end of this lesson, we can conclude that chemical pollutants have a major effect on the environment and the health of living organisms. Pollution of water, soil, and air leads to serious environmental damage, while exposure to pollutants affects human health in multiple ways, including respiratory diseases, nervous system disorders, and difficult diseases such as cancer. It is important to take steps to minimize pollution and preserve environmental and human health

4 – 3 Biodiversity and species protection

Get ready

Biodiversity is the foundation upon which the balance of ecosystems is based and supports life on Earth. Many species are at risk of extinction due to environmental changes, which require actions to protect them.

In this lesson, we will learn about the importance of biodiversity, the impact of environmental changes on living organisms, and strategies to protect endangered species.

Biodiversity means the great variety of living organisms on planet Earth, and includes:

- Genetic diversity
- Diversity between species (such as animals, plants, bacteria, and fungi)
- Ecological diversity (the difference in environments and natural habitats that support these species), This diversity contributes to the sustainability of life on Earth.

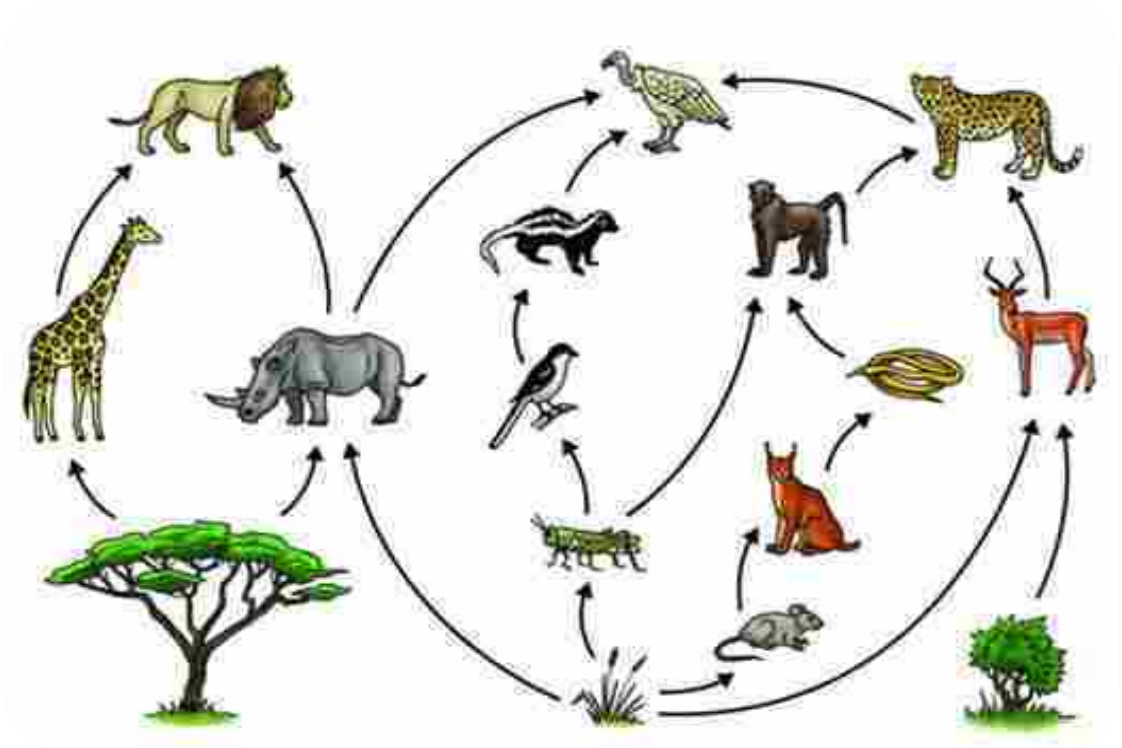
First: The importance of biodiversity in maintaining the balance of ecosystems

Chemical pollutants: toxic substances that can enter the environment and cause damage. These include:

Pesticides: Chemicals used to control insects and the diseases they cause, such as Dieldrin and chlordane

Heavy metals: such as lead, mercury, and cadmium, that accumulate in the environment and in the cells of living organisms

Volatile organic compounds: such as benzene, formaldehyde, and chloroform, which can evaporate into the air and pollute it



1. Stability of ecosystems:
Biodiversity enhances the stability of ecosystems by providing a complex network of interactions between different species.
For example, in tropical forests, the diversity of trees contributes to soil stability and prevents erosion, and it also provides habitats for a wide range of other animals and plants.

2. Supporting food chains:
In ecosystems, one organism depends on another as a food source. Biodiversity ensures the presence of diversity in food resources, which helps maintain food chains.
For example, tigers in forests depend on a diversity of prey such as deer and wild boars, and in the absence of this diversity, the food chain may be disrupted

3. Disease resistance:
Ecosystems with more biodiversity are more resistant to diseases. If there are a large number of species in an ecosystem, diseases are less likely to spread, because a disease may affect one species without quickly spreading to others.

4. Pollination and seed dispersal:
Many plants rely on animals to transport pollen and seeds. For example, bees and butterflies play a crucial role in pollinating plants, which contributes to the production of fruits and seeds that feed many other organisms.

5. Climate regulation:
Biodiversity contributes to the regulation of local and global climate through the role of plants in absorbing carbon dioxide (CO_2) and releasing oxygen (O_2) during photosynthesis process.

Strategies for the Protection of Endangered Species

To protect endangered species, some strategies have been developed that aim to preserve biodiversity and ensure the survival of threatened species. These strategies include:

1. Establishing nature reserves:
Establishing nature reserves is one of the most important ways of protecting endangered species. For example, the Masai Mara Reserve in Kenya provides a safe shelter for many species of wild animals such as lions and elephants and also protects them from illegal hunting and loss of natural habitat, Ras Mohammed Reserve, and Tiran and Snafir Islands Reserve in South Sinai Governorate.

2. Captive breeding programs:
These programs aim to breed endangered species in dedicated centers, then release them into the wild when conditions are favorable. For example, the southern white rhinoceros breeding program contributed to increasing its numbers after it was threatened with extinction.

3. Laws and legislation:

Enforce laws to protect endangered species and prevent illegal hunting and logging. The Convention on International Trade in Endangered Species (CITEs) is an example of international efforts to prevent illegal trade in threatened animals and plants.

4. Awareness and education:

Raising people's awareness of the importance of conserving endangered species and encouraging them to adopt sustainable practices. Also, awareness programs in schools and communities help spread awareness about the importance of biodiversity and species protection.

5. Habitat rehabilitation (Restoring natural habitats):

Rehabilitating damaged areas such as forests or coral reefs to help restore endangered species. For example, reforestation efforts in the Amazon help restore natural habitats for native species.

Successful examples of conservation strategies

1. Bald Eagle:

The bald eagle in the United States was endangered due to the use of the pesticide DDT, which affected the birds' reproduction. And because of the laws that banned the use of DDT and conservation programs, the eagle population increased dramatically, and it was removed from the endangered species list.

Bald eagle

2. Southern White Rhinoceros:

Because of the conservation and captive breeding efforts, the southern white rhino population has increased from near extinction, showing the effectiveness of these strategies.

White rhino

Research and Investigation (Activities)

Activity 1

Research Project

Students are divided into groups and asked to research an endangered species in Egypt and present a report on the causes of the threat and possible protection strategies.

Activity 2

Presentation:

Prepare a presentation on the importance of biodiversity, including facts, figures, and examples of threatened species.

Activity 3

Experiment:

Conduct a simple experiment that demonstrates the effect of environmental changes (such as temperature) on the growth of plants or microorganisms.

Activity 4

: Field trip:

Organize a visit to a nature reserve or wildlife research center to understand the conservation efforts

Check your understanding

[1] Choose the correct answer

1) What is meant by genetic diversity?

Ⓐ ○ Differences in colors between plants

Ⓑ ○ Genetic differences between individuals within a species

Ⓒ ○ The number of species in a given area

Ⓓ ○ Differences in species between different environments

2) How does biodiversity contribute to improving soil quality?

Ⓐ ○ By increasing precipitation

Ⓑ ○ By decomposing organic matter and recycling nutrients

Ⓒ ○ Through rapid climate change

Ⓓ ○ By absorbing carbon dioxide only

3) What is the effect of deforestation on biodiversity?

Ⓐ ○ leads to an increase in the number of species

Ⓑ ○ increases the natural fertility of the soil

Ⓒ ○ causes habitat loss and threatens species survival

Ⓓ ○ leads to decrease carbon dioxide in atmospheric

4) How does biodiversity contribute to climate regulation?

Ⓐ ○ By reducing genetic diversity

Ⓑ ○ By absorbing carbon dioxide by plants

Ⓒ ○ By reducing diversity between species

Ⓓ ○ By directly reducing the Earth's temperature

[2] Explain the importance of biodiversity in supporting life and sustaining ecosystems. Provide illustrative examples.

[3] How do environmental changes, such as climate change and pollution, affect different species? Discuss examples.

[4] What are the strategies used to protect endangered species? How can they be applied in our daily lives??

Evaluate

After studying the importance of biodiversity and the impact of environmental changes on species, develop a plan to protect a specific endangered species in your local environment. Provide a report outlining the plan and outlining actions that can be taken to preserve the species from extinction, emphasizing cooperation between individuals and the community.

Conclusio

At the end of the lesson, students should recognize the importance of biodiversity and its role in maintaining the balance of ecosystems, as well as the challenges facing species and ways to protect them. By increasing the awareness and collective work, we can all contribute to protecting our planet

Final Project

'A mission of restoring the ecosystem'

Imagine that you live in a desert oasis, which has been hit by a massive sandstorm. The local ecosystem has been damaged, the groundwater has been affected, and the soil has been degraded, affecting the lives of plants and animals. Your task is to develop a scale model that represents a comprehensive plan to rebuild and sustain the ecosystem, utilizing what you have learnt about sustainable aquatic, atmospheric and soil ecology.

The final product

'A scale model of a sustainable desert ecosystem in a desert oasis'

In this project, you will create a scale model of an ecosystem that includes elements of sustainable soil, a clean water environment, and air protection from pollution. You will employ the ecosystem health maintenance techniques and sustainable strategies you learnt during the unit.

Procedural steps:

1. **Understanding the Oasis Ecosystem**
   - Review the concepts you have studied about the atmosphere and the impact of natural disasters on air environments.
   - Analyze how sandstorms affect air quality in the oasis and use strategies to purify it.

2. **Design a sustainable soil system**
   - Based on your knowledge of sustainable soils, optimize the soil in your scale model by adding organic matter and improving the soil structure to enhance its ability to support native plants.
   - Recycle organic matter to enhance the fertility of degraded soil and add materials such as lime to minimize the impact of acid rain.
3. **Rebuild the water system**
   - Create a water source representing lakes or wells in your scale model and use water purification techniques such as natural filtration (using sand and charcoal).
   - Utilize the concepts you have studied about sustainable aquatic ecology to ensure that the water is usable for irrigation and plant life.
4. **Design a system to improve air quality**
   - Use what you have learnt about the atmosphere and air environment to design ways to improve air quality in the oasis after a sandstorm, such as adding plants that can reduce air pollution or designing natural barriers that protect against storms.
5. **Design an effective thermal system:**
   - Use your study of the concept of specific heat to design systems to protect the local flora and fauna from large thermal changes in the desert.
   - Test different materials for their ability to absorb and store heat, then use them in your scale model to optimize temperature regulation in soil and water.
6. **Apply recycling and waste reduction strategies**
   - Apply what you have learnt about soil and natural resources by designing a recycling system for plant waste within your scale model. Use organic matter to improve the soil and minimize waste.
7. **Prepare your final presentation**
   - After finalizing the model, prepare a presentation showing the stages of ecosystem reconstruction. The presentation should include how you incorporated the elements of sustainable soil, clean water environment, and air protection into the model. Use graphs and images to support your presentation.

Discussion

- After finalizing your project, what factors do you think are most influential in restoring a sustainable ecosystem after a natural disaster?
- How can similar techniques be used to improve the resilience of other ecosystems in Egypt or in other desert environments around the world?