



Discover and Learn

SCIENCE

Second Preparatory - Second Term

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Student's Book

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Introduction

Dear student,

We are pleased to present this Science textbook to our second preparatory students, and to emphasise the role of science in the development and progress of society. Science is not just a subject to be studied, It is a way of thinking that helps them to understand the world more deeply and make well-informed decisions based on precise knowledge. Learning science is an active process based on discovery, research, experimentation, thinking, and practicing different scientific processes such as observation, interpretation, communication, prediction, experimentation, and drawing conclusions. Reflecting this philosophy, the curriculum has been entitled : 'Discover and Learn!'

This book aims to foster students' love of exploration and experimentation, encouraging critical thinking, collaboration, and questioning—guiding them to discover answers through observation, hands-on experiments, and diverse activities that make scientific concepts engaging and fun. This book also aims to help students develop a deep understanding of scientific concepts, apply scientific knowledge in new situations, solve problems, develop scientific research and inquiry skills. The content encourages students to ask questions, design experiments, analyse information, develop innovative solutions, and enhance understanding of the relationships between science, technology, engineering and mathematics.

It also prepares students to be lifelong learners and capable of meeting future challenges.

To achieve these goals, this book covers different fields of science such as chemistry, physics, biology, and space science in cohesive, interconnected units that also align with other subjects. This promotes a comprehensive and integrated understanding of how these fields intersect in the real world. The topics covered in this curriculum address key concepts in the fields of matter, energy, living things, and space, which helps to encourage scientific inquiry.

The curriculum relies on active learning strategies in the implementation of its lessons, addresses many scientific and social issues and reinforcing values. The lessons are supported by knowledge resources, communication and information technology, encouraging research and self-learning skills, developing critical thinking skills, and helping students reflect on and assess their understanding of what they are studying and learning.

We hope that you will find inspiration in this book to encourage you to pursue your scientific curiosity. Always remember that scientists were once just curious children like you. They search for answers to their questions and discovered new wonders. Maybe you will be one of the scientists who discover what no one has discovered before!

In presenting this book, we hope that it will be of benefit to you.

And God is the source of all success.
The Authors

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UNIT 1

Thermal Energy and Changes of Matter

Unit lessons

Lesson one : Thermal Changes Accompanying Physical Changes.

Lesson two : Thermal Changes Accompanying Chemical Changes.

Lesson three : Combustion, Oxidation, and Reduction.

Learning Outcomes :

By the end of this unit, students will be able to:

1. Appreciate the role of the scientist Hermann von Helmholtz in proving the Law of conservation of energy.
2. Describe the interaction of energy with matter in exothermic and endothermic chemical reactions.
3. Test a simple device that releases or absorbs thermal energy from chemical reactions.
4. Explain the effect of the type and concentration of substances used in exothermic and endothermic reactions on thermal energy production or absorption.
5. Deduce the requirements for combustion reactions.
6. Deduce the requirements for extinguishing fires.
7. Demonstrate by experiment that oxidation is the process of gaining oxygen, while reduction is the process of losing oxygen.

Lesson One

Thermal Changes Accompanying Physical Changes.



Lesson Terminology :

- Heat of Dissolution
- Refrigeration Cycle.
- Exothermic Dissolution.
- Endothermic Dissolution.
- Initial Temperature.
- Final Temperature.
- Instant Cold Compresses.
- Instant Hot Compresses.



Included skills, Values, and Issues :

- **Skills** : Practical - Mathematical - Cognitive
- **Values** : Self-preservation.
- **Issues** : The impact of thermal processes in industry on greenhouse gas emissions.



Cross-Cutting Concepts :

- Cause and effect.



Lesson Objectives :

By the end of the lesson, students will be able to :

- 1 Define hydrates (hydrated substances) and anhydrous substances.
- 2 Distinguish between exothermic dissolution and endothermic dissolution.
- 3 Follow safety precautions when diluting concentrated acids.
- 4 Determine the relationship between the thermal change accompanying the dissolution process and mass of the solute.
- 5 Give examples of life applications for thermal changes accompanying physical changes.



Lesson Introduction:

The figure shows the evolution of carbon dioxide gas from a fizzy drink when the container is opened and poured.

This lesson explores ideas that will help you answer the questions below.

- Is the release of gas from a solution considered a physical or a chemical change?
- Does this change occur by releasing or absorbing heat?
- Why do we feel cold and refreshed when drinking fizzy drinks?



What do you feel when rubbing your hands using:

- Antiseptic hand gel (Figure 1).
- Laundry (detergent) powder and water (Figure 2).



Figure (1)



Figure (2)

Our hands feel cold when using antiseptic hand gel because the evaporation of alcohol absorbs heat from the hands. This process is described as **endothermic**.

Meanwhile, our hands feel warm when dissolving laundry powder in water due to the release of heat during the dissolution process. This process is described as **exothermic**.

Cumulative knowledge

- Processes of changing states of matter include melting, evaporation, freezing, condensation, sublimation, and deposition. These are reversible processes that do not involve breaking chemical bonds or forming new ones.



Check Your Understanding

Classify the six processes of state transformation into endothermic or exothermic.

- Endothermic processes:
- Exothermic processes:



Technological Application

Refrigeration Cycle in the Refrigerator

This cycle is a closed and repeating thermal process where heat is extracted from inside the refrigerator and transferred to the surrounding medium (air), using a refrigerant (such as eco-friendly freons). This cycle involves both endothermic and exothermic processes. The freon passes through several stages, as shown in Figure (3):

- (1) **Expansion and evaporation:** The liquid freon passes through a narrow valve, turning into a cold gas that absorbs heat from the food inside the refrigerator.
- (2) **Compression:** The compressor (fridge motor) draws in the gas and compresses it, causing its temperature to rise.
- (3) **Condensation:** The hot gas passes through the pipe network located behind the refrigerator, cools down and turns into a liquid again. This is accompanied by releasing heat to the surrounding medium.
- (4) The refrigeration cycle is repeated continuously.

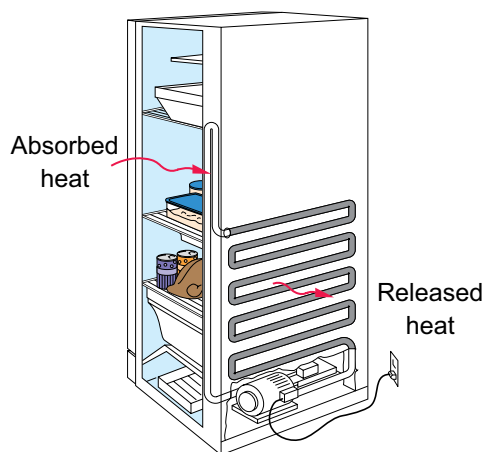


Figure (3)

Refrigeration cycle in the refrigerator

Thermal Changes Accompanying Dissolution

Processes of changing states of matter and the process of dissolution are physical processes accompanied by the **release** or **absorption** of thermal energy to or from the surroundings.

Activity 1 Practical Work

Materials and Tools:

- Water.
- Solid sodium hydroxide $\text{NaOH}_{(s)}$.
- Solid ammonium nitrate $\text{NH}_4\text{NO}_{3(s)}$.
- Heat-insulating polystyrene cups.
- Graduated cylinder.
- Laboratory thermometer.
- Sensitive balance.

Steps:

- 1 Place 100 ml of water in a polystyrene cup.
- 2 Record the initial temperature T_1 of the water using the thermometer.
- 3 Add 4 g of solid sodium hydroxide to the cup, cover the cup with the lid, and stir gently with the thermometer.
- 4 After 15 seconds, record the final temperature T_2 . (Figure 4).

Which is greater, T_1 or T_2 ?

.....

- 5 Repeat the previous steps using 8 g of solid ammonium nitrate.

Which is greater, T_1 or T_2 ?

What do you conclude?

.....

.....

- 6 **How can** you increase thermal insulation when performing this experiment?

.....

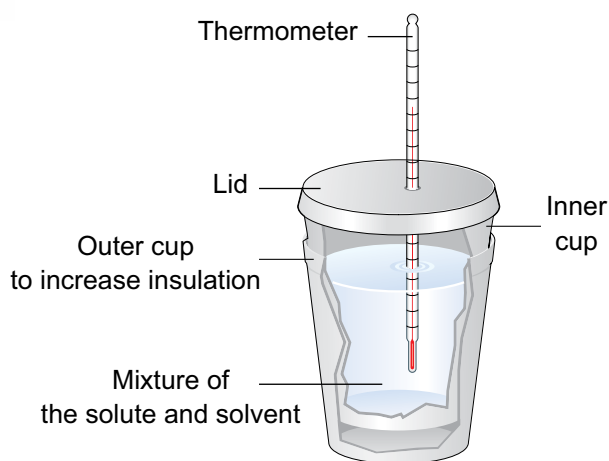


Figure (4)

- The dissolution of some substances, such as **Sodium Hydroxide, Calcium Chloride, Sodium Carbonate, and Anhydrous Copper sulphate** in water (Figure 5), leads to **raising** the temperature of water.

The physical change of dissolving a substance in water, which is accompanied by the **release** of thermal energy, is described as **exothermic dissolution**.

- The dissolution of some substances, such as **Ammonium Nitrate, Potassium sulphate, Sodium Bicarbonate, and Hydrated Copper sulphate** in water, leads to **lowering** the temperature of water.

This physical change of dissolving a substance in water, which is accompanied by the **absorption** of thermal energy, is described as **endothermic dissolution**.

- The heat change (amount of heat absorbed or released) when dissolving a specific quantity of solute in a known volume of solvent to form a solution is called the **heat of dissolution**.

-The substance whose molecules can bind with a specific number of water molecules is known as a hydrated substance. Water molecules can be removed from the hydrated substance molecule by heating, that becomes an anhydrous substance. The anhydrous substance can be converted back to its hydrated form by adding drops of water to it.

Tables (1) and (2) illustrate two examples of such substances.

Table (1)

Salt	Colour
Hydrated copper sulphate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}_{(\text{s})}$	Blue
Anhydrous copper sulphate $\text{CuSO}_{4(\text{s})}$	White

Table (2)

Salt	Colour
Hydrated cobalt chloride $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}_{(\text{s})}$	Pink
Anhydrous cobalt chloride $\text{CoCl}_{2(\text{s})}$	Blue



Figure (5)

Formation of blue copper sulphate from white copper sulphate is an exothermic process.

Laboratory safety precautions

- When adding water to a concentrated acid, a large amount of thermal energy is released, causing immediate violent boiling of the water, which leads to acid splashing out of the reaction container (Figure 6). This may cause severe damage. Therefore, when diluting concentrated acids, the acid should be dripped onto the inner walls of the container holding the water, and not the reverse, so the water absorbs the released heat without causing damage.

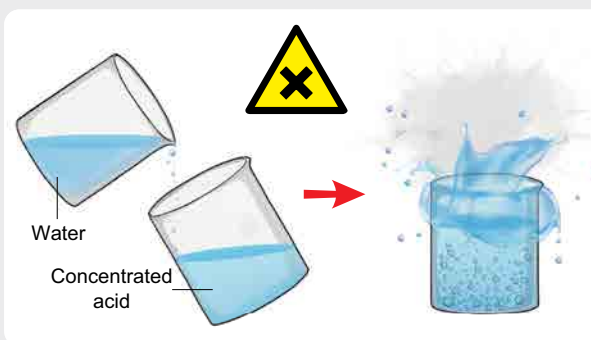


Figure (6)

Danger of adding water to concentrated acid

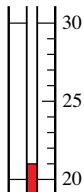
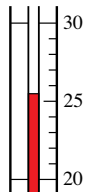
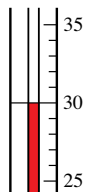
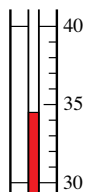
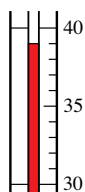
Relationship Between Thermal Change Accompanying Dissolution and Solute Mass

Activity 2 Calculate and Conclude

An experiment was conducted to determine the amount of thermal change accompanying the dissolution of 1 g of anhydrous lithium chloride $\text{LiCl}_{(s)}$ salt in 30 ml of distilled water. The experiment was repeated using different masses of the salt, keeping the water volume constant.

- **Record** the initial temperature T_1 and final temperature T_2 after 30 s for each case as shown in (Table 3).
- **Calculate** the change in temperature in each case.

Table (3)

Experiment	The mass of solute used	Initial temperature T_1		Final temperature T_2		The change in temperature ΔT
①	1 g		21°C		25.5°C	$25.5 - 21 = 4.5^\circ\text{C}$
②	2 g		.....		.....	.....
③	3 g		.....		.....	.....
④	4 g		.....		.....	.....

- **Is** the dissolution of anhydrous lithium chloride salt in water exothermic or endothermic?

- **Identify** each of the independent, dependent, and control variables in this activity.

- Plot the relationship between the change in temperature and the mass of the dissolved salt in a specific volume of water on the graph grid (Figure 7). Then, deduce the relationship between them.

.....

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- Predict the change of water temperature when dissolving 6 g of the same salt in 30 ml of water.

.....

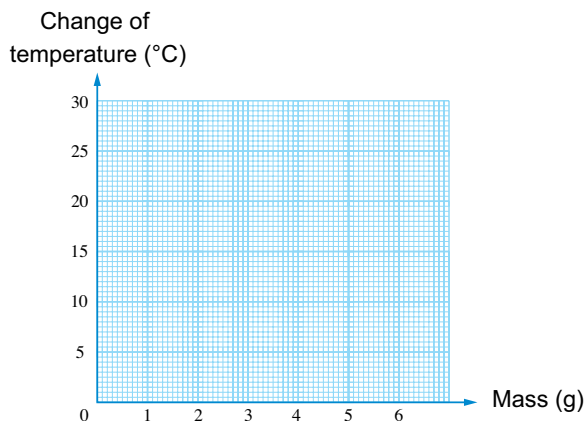


Figure (7)

Based on the above, it is concluded that:

The quantity of thermal energy released as a result of the dissolution process is directly proportional to the mass of the dissolved salt in a constant volume of the solvent (water).



Cross-Cutting Concepts: Cause and Effect

Doubling the mass of the solute while keeping the solvent (water) volume constant (Cause), usually leads to doubling the change in temperature (Effect).



Life Application

Instant Hot and Cold Compresses Packs

- These compresses are used only once. They consist of a flexible bag containing a chemical substance (solute) and water inside a thin bag (Figure 8) that ruptures upon pressure. Thus, the solute mixes with the water, and either an endothermic or exothermic dissolution occurs.

- Instant Hot Compresses: contain Magnesium sulphate salt. they are used to relieve pain associated with muscle fatigue by Widening blood vessels, which increases blood flow to the fatigued areas, relaxing contracted muscles and relieving pain.
- Instant Cold Compresses: contain Ammonium Nitrate salt. they are used to reduce the severity of swelling (Figure 9) by narrowing blood vessels, which reduces blood flow to the injured area, thus reducing swelling.



Figure (8)

Instant cold compresses and hot compresses



Figure (9)

Cold compresses are used to relieve swelling



Research Activity

Search various knowledge sources for how Sodium Acetate salt is used in cooling processes.



Issue for Discussion

Thermal processes in industry and their impact on the emission of greenhouse gases.

Assessment of Lesson One



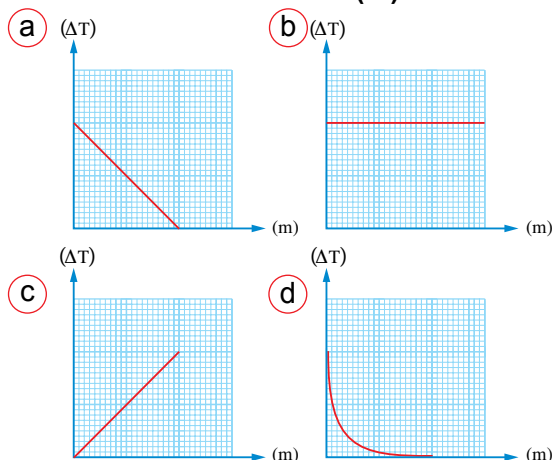
1 Choose the correct answer for questions (1) – (6).

- (1) The following table shows initial temperatures (T_1) for water and final temperatures (T_2) after dissolving different substances in the same volume of water.

Trial	T_1 ($^{\circ}\text{C}$)	T_2 ($^{\circ}\text{C}$)
(1)	19	29
(2)	20	16
(3)	22	17
(4)	22	26

In which dissolution the greatest amount of thermal energy is absorbed?

- a (1). b (2). c (3). d (4).
- (2) What is the substance that changes colour from blue to pink when drops of water are added to it?
- a Anhydrous cobalt chloride.
b Anhydrous copper sulphate.
c Hydrated cobalt chloride.
d Hydrated copper sulphate.
- (3) Which of the following graphs represents the relationship between the temperature change (ΔT) for an exothermic dissolution process and the mass of the solute (m)?



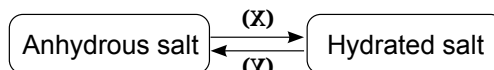
- (4) What change occurs in all endothermic processes?

- a A change in the solution colour.
b Solid substances melt.
c A gas evolves.
d The temperature of the surrounding medium decreases.

- (5) The dissolution of the following substances in water is accompanied by the release of thermal energy, except

- a Sodium hydroxide.
b Calcium chloride.
c Sodium carbonate.
d Sodium bicarbonate.

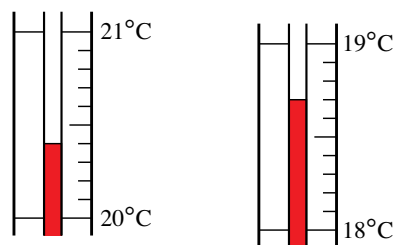
- (6) From the following diagram:



Which of the following expresses (X) and (Y)?

- a (X): Heating, (Y): Adding water.
b (X): Heating, (Y): Removing water.
c (X): Adding water, (Y): Heating.
d (X): Adding water, (Y): Cooling.

- 2 Figures show the initial and final temperatures of water before and after dissolving substance (X) in it, inside two nested polystyrene cups.



Initial temperature Final temperature

- (1) Is the dissolution process exothermic or endothermic? Explain your answer.
(2) Is substance (X) Calcium Chloride or Ammonium Chloride? Explain your answer.
(3) Why was the experiment conducted inside two nested cups instead of just one cup?

Lesson Two

Thermal Changes Accompanying Chemical Changes



Lesson Terminology :

- Law of Conservation of Energy.
- Exothermic Reaction.
- Endothermic Reaction.
- Thermite Reaction.
- Bond Breaking.
- Bond Forming.



Included Skills, Values, and Issues:

- **Skills** : Practical - Mathematical - Cognitive.
- **Values** : Appreciating the role of scientists.
- **Issues** : The role of chemical reactions in energy sustainability.



Cross-Cutting Concepts :

- Cause and Effect.



Lesson Objectives :

By the end of the lesson, students will be able to :

- 1 Deduce the Law of Conservation of Energy.
- 2 Appreciate the role of scientist Helmholtz in discovering the Law of Conservation of Energy.
- 3 Differentiate between exothermic and endothermic reactions.
- 4 Mention examples of both exothermic and endothermic reactions.
- 5 Mention real-life applications of exothermic reactions.
- 6 Explain the relationship between chemical reactions and the Law of Conservation of Energy.



Lesson Introduction :

The figure shows fizzy candy containing a mixture of Sodium Bicarbonate and Citric Acid. It gives a refreshing sensation when placed in the mouth.

This lesson explores ideas that will help you answer the questions below.

- What causes this refreshing sensation?
- What type of reaction occurs when the candy is placed in the mouth?
- What is the relationship between this reaction and the Law of Conservation of Energy?



You have learned, in the first semester, that when a chemical reaction occurs, the reactants are not destroyed but rearranged, and new substances are not created from nothing. Instead, the atoms of the reactants are rearranged to form new products keeping the number of atoms for each element unchanged. That fulfills the Law of **Conservation of Matter**.

However, what about energy in chemical reactions??

Activity 1 Practical Work

Materials and Tools:

- 2 Lemons.
- Two zinc rods (Zn).
- LED bulb.
- Two copper rods (Cu).
- Connecting wires.

Steps :

- 1 Insert a copper rod and a zinc rod into each lemon.
- 2 Connect the zinc rod in the first lemon to the copper rod in the second lemon with a connecting wire.
- 3 Connect the other copper and zinc rods to the LED bulb (Figure 1).

What do you observe?

.....

.....

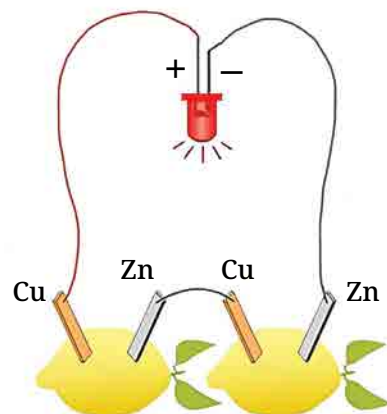


Figure (1)
Lemon battery

Based on the above, it is concluded that:

It is possible to convert the chemical energy stored in lemon juice into electrical energy, fulfilling the Law of Conservation of Energy.

Scientist Profile:

Hermann von Helmholtz

A German scientist who proved that energy is neither destroyed nor created, but can be converted from one form to another. The total energy remains constant within an isolated system. This is known as the **Law of Conservation of Energy**.

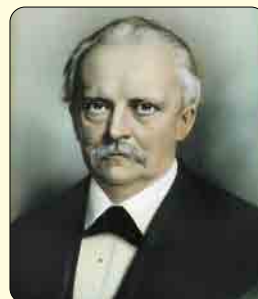


Figure (2)
Scientist Helmholtz

Chemical Reactions and Thermal Changes

Chemical reactions are usually accompanied by thermal changes, appearing as energy absorbed from, or released to the surroundings.

First Exothermic Reactions

Activity 2 Practical Work

Materials and Tools:

- Dilute hydrochloric acid.
- Magnesium ribbon.
- Two nested polystyrene cups.
- Laboratory thermometer.

Steps :

- 1 Place 50 ml of dilute hydrochloric acid in the nested polystyrene cups (Figure 3).
- 2 Record the initial temperature (T_1) using the thermometer.
- 3 Immerse the magnesium ribbon in the acid while stirring gently with the thermometer.
- 4 Record the final temperature (T_2) reached by the reaction mixture.

Which is greater, T_1 or T_2 ?

The reaction of magnesium with dilute hydrochloric acid is accompanied by the release of thermal energy, leading to an increase in the temperature of the system (reaction mixture), which in turn leads to an increase in the temperature of the surroundings.

This reaction is described as **Exothermic** and is expressed by the following thermochemical equation:



Based on the above, it is concluded that:

Exothermic Reactions: Reactions that release thermal energy to the surrounding medium as a product, causing the temperature of surroundings to rise. (Figure 4).

Examples of Exothermic Reactions:

- Reaction of metals with dilute acids.
- Reaction of alkalis with acids.
- Reaction of metal carbonates with dilute acids.

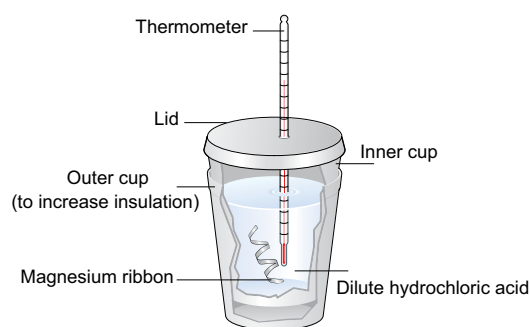


Figure (3)

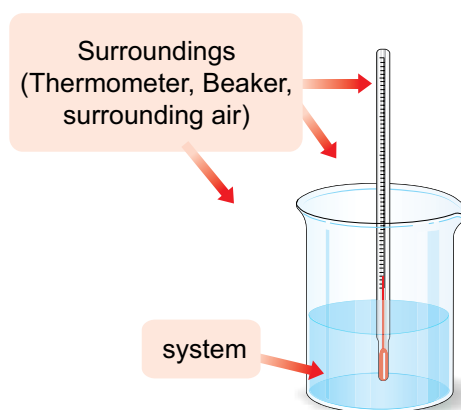


Figure (4)

Heat transfers from the system to the surroundings in Exothermic Reactions.



Integration with Life Sciences (Biology)

Luminous Insects, like Fireflies, (Figure 5) emit light from their abdominal area as a result of exothermic chemical reactions occurring inside their bodies. In these reactions, most of the resulting energy is converted into light (not heat). These insects control the timing and duration of the light they use for various purposes such as mating and self-defense.



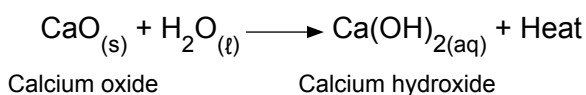
Figure (5)
Luminous insect



Life Applications

1 Self-heating Cans.

These cans contain an inner cone holding Calcium Oxide (CaO) (Quicklime) and water, separated by a thin membrane. When a button at the bottom is pressed, the membrane ruptures, and an exothermic chemical reaction occurs, forming Calcium Hydroxide Solution (Lime water). The released heat is used to warm coffee or heat the food inside the can (Figure 6).



Calcium hydroxide powder is known as “slaked lime”.



Figure (6)
Self-heating can

2 Thermite reaction.

The reaction of aluminium with red iron oxide is accompanied by the release of a large amount of thermal energy, leading to the melting of the iron produced from the reaction. Accordingly, this reaction is used in welding railway tracks (Figure 7).

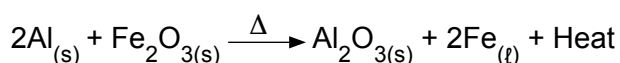


Figure (7)
Welding rails using the thermite reaction.

Activity 3 Practical Work

Materials and Tools :

- Barium hydroxide powder $\text{Ba}(\text{OH})_2$
- Ammonium chloride powder NH_4Cl
- Water.
- Glass rod.
- Wooden block.
- Digital thermometer.
- Glass flask.

Steps :

- 1 Wet the wooden block with a little amount of water, then place a glass flask containing Barium hydroxide powder on top of it.
- 2 Record the initial temperature of the powder (T_1) using the digital thermometer (Figure 8).
- 3 Add ammonium chloride powder to the flask and stir the mixture well with the glass rod.
- 4 Record the final temperature (T_2). Which is greater T_2 or T_1 ?

What do you observe when lifting the flask (Figure 9)?

The reaction of barium hydroxide with ammonium chloride is accompanied by the absorption of thermal energy, leading to a decrease in the temperature of the system, which in turn leads to a decrease in the temperature of the surroundings. This is shown by the freezing of the water layer confined between the beaker and the wooden block, causing them to stick together.

This reaction is described as **Endothermic**.

Based on the above, it is concluded that:

Endothermic Reactions that absorb thermal energy from the surrounding medium, causing the temperature of surroundings to lower.

Examples of Endothermic Reactions:

- Thermal decomposition reaction of Limestone (Calcium carbonate CaCO_3).
- Decomposition reaction of Ozone gas (O_3) in the atmosphere.
- Reaction of Sodium Bicarbonate with dilute acids.



Figure (8)



Figure (9)



Research Activity

Search various knowledge sources, including the INTERNET and your school library, for the composition of airbags used in modern cars for protection during sudden stop or crash, and the thermal reactions that take place inside them.

Relationship Between Chemical Reactions and Law of Conservation of Energy

A chemical reaction occurs by breaking bonds between the atoms of reactant molecules and forming new bonds between the atoms of product molecules. Breaking bonds is an **Endothermic** process (Heat-absorbing). Forming bonds is an **Exothermic** process (Heat-releasing). In most cases, for the same reaction, the amounts of energy absorbed and energy released in breaking and forming bonds are not equal.



Activity 4 Calculate and Conclude

Figure (10) shows the reaction of hydrogen gas with oxygen gas to form water, according to the following balanced equation:

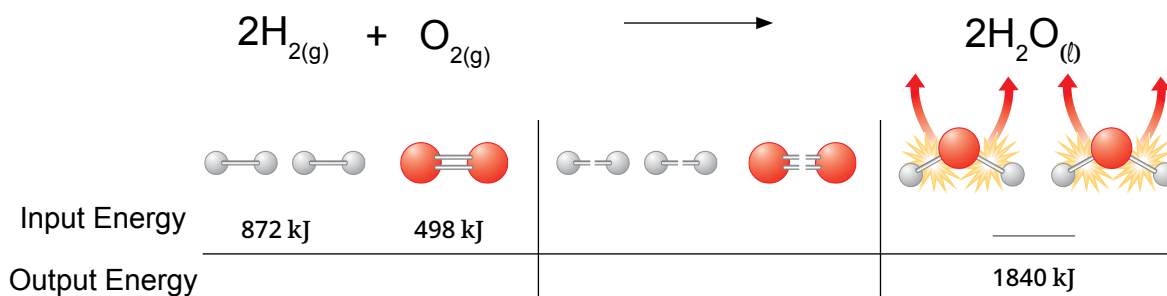


Figure (10)

- What is the total energy absorbed when breaking bonds (input energy)?

..... + = kJ

- What is the total energy released when forming bonds (output energy)?

..... kJ

- Which is greater: The absorbed energy when bonds are broken or the released energy when bonds are formed?

.....

When the amount of energy released from forming new bonds (in product molecules) **is greater than** the amount of energy absorbed when breaking bonds (in reactant molecules), the difference appears as thermal energy released from the reaction, fulfilling the **Law of Conservation of Energy**.

This is what happens in **exothermic** reactions which can be represented by the energy diagram in (Figure 11).

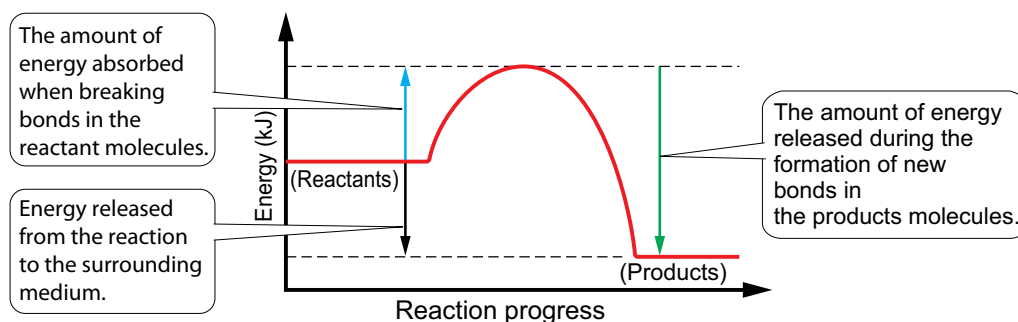


Figure (11)

Energy diagram for an exothermic reaction

When the amount of energy released from forming new bonds in (in product molecules) **is less than** the amount of energy absorbed when breaking bonds (in reactant molecules), the difference appears as thermal energy absorbed from the surrounding medium, fulfilling the **Law of Conservation of Energy**.

This is what happens in **endothermic** reactions which can be represented by the energy diagram in (Figure 12).

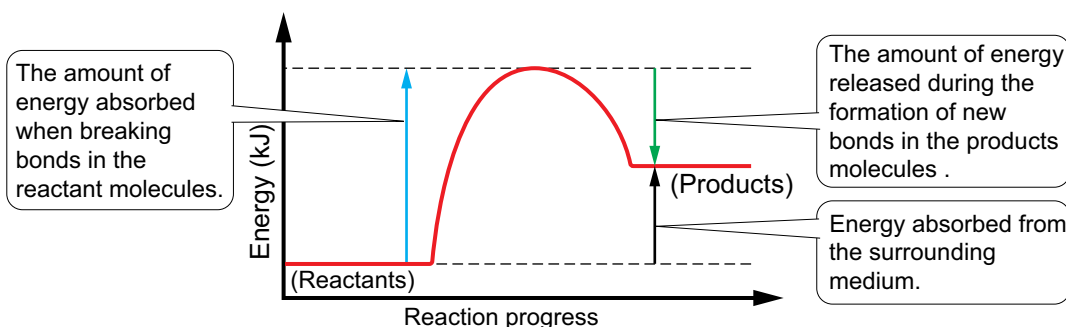


Figure (12)

Energy diagram for an endothermic reaction



Cross-Cutting Concepts : Cause and Effect

The higher the bond energy (**Cause**), the more difficult it is to break the bond (**Effect**).



Issue for Discussion

The role of chemical reactions in energy sustainability.

Information and Communication Technology



Use the free ORCA app to calculate the thermal changes accompanying chemical reactions.

Assessment of Lesson Two



1 Choose the correct answer for questions (1) – (4).

(1) The dissolution of which of the following substances in water leads to a chemical change accompanied by the release of thermal energy?

- (a) Sodium hydroxide.
- (b) Calcium oxide.
- (c) Calcium carbonate.
- (d) Sodium chloride.

(2) You have got two reactions:

- (1) Sodium carbonate + dilute sulphuric acid.
- (2) Sodium bicarbonate + dilute sulphuric acid.

Which of the following correctly describes reactions (1) and (2)?

Choices	Reaction (1)	Reaction (2)
(a)	Endothermic	Exothermic
(b)	Endothermic	Endothermic
(c)	Exothermic	Exothermic
(d)	Exothermic	Endothermic

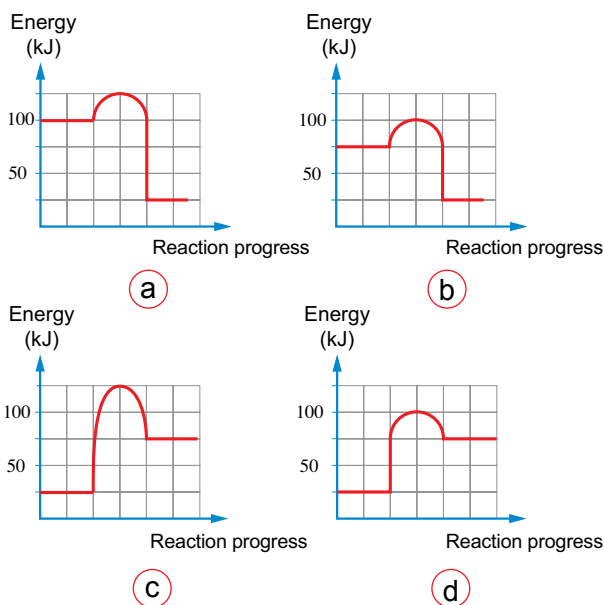
(3) The following table shows the initial temperatures (T_1) and final temperatures (T_2) for four chemical reactions with the same amount of reactants.

Reaction	$T_1(^{\circ}\text{C})$	$T_2(^{\circ}\text{C})$
(1)	22	17
(2)	21	25
(3)	20	27
(4)	20	18

Which of these reactions has absorbed the greatest amount of thermal energy?

- (a) (1).
- (b) (2).
- (c) (3).
- (d) (4).

(4) Which of the following graphs represents an exothermic reaction that releases the least amount of thermal energy?



2 Hydrogen gas reacts with chlorine gas according to the following thermochemical equation:



- (1) Is this reaction exothermic or endothermic? Explain your answer.
- (2) Which is greater: The energy absorbed during breaking bonds or the energy released during forming new bonds?

3 Draw the energy diagram for an endothermic reaction.

4 Write the thermochemical equation expressing the thermite reaction, then mention the importance of this reaction.

Lesson Three

Combustion, Oxidation, and Reduction



Lesson Terminology :

- Fire Triangle
- Combustion
- Fossil Fuel
- Fuel Value
- Steel Wool
- Ignition Point
- Oxyacetylene Flame
- Oxidation
- Reduction
- Oxidizing Agent
- Reducing Agent



Included Skills, Values, and Issues :

- **Skills** : Practical.
- **Values** : Cooperation.
- **Issues** : Using science to confront superstitions.



Cross-Cutting concepts:

- Cause and Effect.



Lesson Objectives :

By the end of the lesson, students will be able to :

- 1 Differentiate between elements of Fire triangle (Combustion).
- 2 Explain the process of spontaneous combustion.
- 3 Determine methods of extinguishing fires.
- 4 Differentiate between oxidation and reduction processes.



Lesson Introduction :

The figure shows an Olympic Torch held by a runner.

This lesson explores ideas that will help you answer the questions below :

- What are the basic elements required to light the torch?
- How can the torch flame be extinguished?
- What is the meaning of Oxidation and Reduction?
- What is their relation with the combustion process?



Discuss with your classmates under your teacher's supervision the answers of these questions:

- **Can** a car engine run without **fuel** (Figure 1)?
- **Why** are frying pan fires extinguished by covering them with a metal lid (Figure 2)?
- **Why** does a matchstick ignite when rubbed against a rough surface (Figure 3)?



Figure (1)



Figure (2)



Figure (3)

Combustion

The key elements of the combustion process are:

First: Fuel. **Second:** Oxygen. **Third:** Heat

These elements represent what is known as the Fire Triangle (Combustion Triangle) (Figure 4).

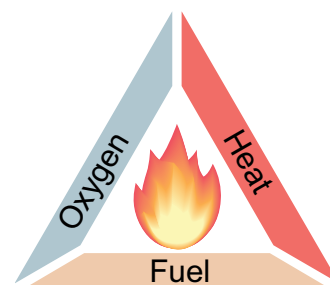


Figure (4)
Fire Triangle

First

Fuel

Fuel is a flammable material used to produce thermal energy (heat) as a result of an exothermic reaction. There are many types of fuel, including:

- ① **Fossil fuel** Such as coal, petroleum, and natural gas. Although they are non-renewable energy resources, they are the most worldwide used till now.

The two main fossil fuels used in homes are:

- **Natural gas** consists mainly of Methane gas (93%), together with some other hydrocarbons like Propane and Butane.
- **Butagas** consists of a mixture of Propane and Butane after being separated from the natural gas.



Issue for Discussion

The environmental impact of burning fossil fuels.

Preventive Awareness

- Since both natural gas and butagas are odorless, a very small amount of Ethanethiol gas, which has a garlic-like smell, is added to them in order to take appropriate safety measures if a gas leak occurs.

② **Biofuel** : such as Ethyl Alcohol (Ethanol), which is prepared from plants rich in starch, like corn. Therefore, it is considered a renewable energy resource. In some countries, it is mixed with gasoline to be used as car fuel.

③ **Synthetic fuel** (Synfuel) such as Hydrogen gas, which is described as the “fuel of the future” (Figure 5). It is used as fuel for cars and trucks powered by fuel cells (Hydrogen Fuel Cells).

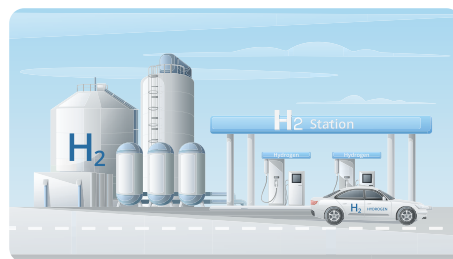


Figure (5)
Hydrogen power plant

Table (1)
Values for illustration only

Fuel	Calorific Value (kJ/g)
Wood	20
Ethanol	30
Natural Gas	50
Hydrogen	143

Table (1) shows energy values in kilojoules (kJ) produced from the combustion of 1 g of different types of fuel in excess of oxygen. This is known as the Fuel Calorific Value.

Second Oxygen gas

Does a piece of steel wool (scouring pad) burn faster in atmospheric air (Figure 6) or in pure oxygen (Figure 7) ?



Figure (6)
Combustion of steel wool in atmospheric air

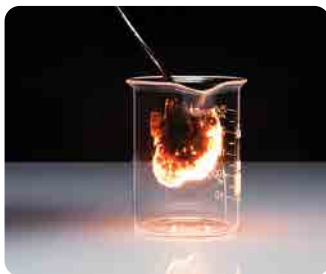


Figure (7)
Combustion of steel wool in pure oxygen

Cumulative Knowledge

- Atmospheric air consists of approximately :
 - 78% Nitrogen gas
 - 21% Oxygen gas
 - 1% Other gases (Figure 8).

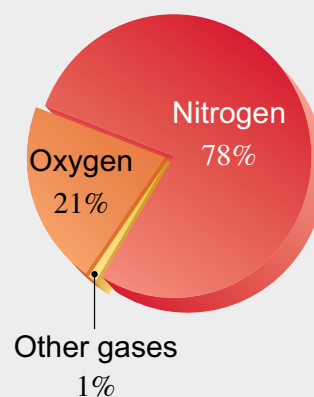


Figure (8)
Components of atmospheric air



Activity 1 Practical Work

Materials and Tools :

- Paraffin candle
- Glass bell jar
- Matchbox

Steps :

- ① Light the candle using a matchstick.
- ② Put the candle under the bell jar.

Why does the candle flame goes out after a few minutes (Figure 9)?

.....

.....

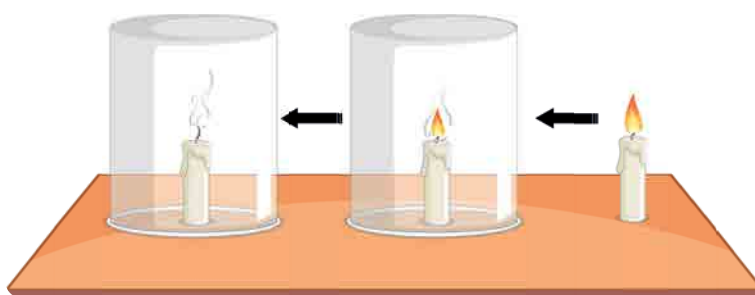


Figure (9)

Based on the above, it is concluded that:

Oxygen is an essential element in the combustion process.

Combustion is the combination of fuel with oxygen which is usually accompanied by the emission of light, heat, or both.

Laboratory Skill

- Bunsen burner is used as a heat source in laboratories. Its flame results from the combustion of a mixture of gaseous fuel and oxygen. The flame colour varies according to the amount of oxygen mixed with the fuel (Figure 10). When the amount of oxygen is limited, the flame turns yellow, and the combustion is described as **incomplete**.

On the other hand, when the air vent (hole) in Bunsen burner is widely opened, the flame turns blue due to the abundance of oxygen, and the reaction is described as **complete**.



Figure (10)

Complete and incomplete combustion in Bunsen burner

Why are spark plugs (Figure 11) used in cars?

When starting the car engine, spark plugs create an electric spark that causes the ignition of gasoline-air mixture in the combustion chambers.

Fuel does not begin to burn until it reaches a specific temperature known as the **ignition point**.

As the ignition point of a fuel is low, its flammability increases. The ignition point differs from one fuel to another, and determines how dangerous using the fuel is .



Figure (11)
Spark plug



Check Your Understanding

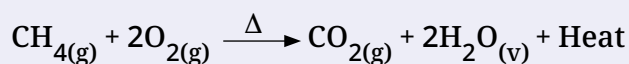
The ignition point of substance (X) is 45°C while the Ignition point of substance (Y) is 300°C. Which of them ignites more readily ? Explain your answer.

.....



Cross-Cutting Concepts : Cause and Effect

Hydrocarbons are composed of carbon and hydrogen (**Cause**). When they burn in the air, carbon dioxide gas and water vapour are formed as products of an exothermic reaction (**Effect**).



Technological Application

Oxyacetylene flame

Acetylene gas burns completely in the presence of excess oxygen. The temperature of its flame reaches 3000°C, Therefore, it is widely used in welding and cutting metals such as steel and copper.



Figure (12)
Oxyacetylene flame is used in cutting metals

Spontaneous Combustion

Can a material catch fire without an external ignition source such as a flame, an electric spark or friction?



Figure (13)

Spontaneous combustion of glycerin and potassium permanganate mixture.

When adding drops of glycerin to potassium permanganate powder, an **exothermic reaction** occurs, leading to spontaneous emission of smoke and formation of a purple-coloured flame.

The phenomenon of material igniting without any external heat source is known as **Spontaneous Combustion** (Ignition).

Science and Confronting Superstitions:

Social media users have shared a video showing a village house in Upper Egypt that caught fire without any clear reason. Some people claimed that this incident could be done by ghosts. Scientifically, the spontaneous combustion of hay and firewood stored on rooftops could be caused by the heat generated from bacterial decomposition that raised temperature until it reached the ignition point.

Extinguishing Fires

Extinguishing fire depends on what is called the fire extinguishing triangle, which is based on three principles :

① Smothering (Isolating Oxygen):

This is achieved using fire extinguishers (Figure 14) that use foam, dry powder, or carbon dioxide gas to isolate the fire from the air.

Also, sand is used to extinguish fires of some metals like sodium and magnesium.



Figure (14)

Training on extinguishing fire

Laboratory Safety Precautions

- It is strictly forbidden to use water to extinguish Sodium or Potassium fires. Doing this will increase the intensity of the fire instead of extinguishing it, because the reaction of these metals with water is exothermic, that causes the evolving hydrogen gas to burn.

- ② **Cooling** By lowering the temperature of the burning materials like paper and wood (Figure 15) to below their ignition point. This is often achieved using water because of its high specific heat.
- Water is NOT used to extinguish oil or petroleum fires. Oil floats on top of water because its density is lower than that of water causing the fire to spread instead of being extinguished.



Figure (15)
Extinguishing forest fires with water

- ③ **Fuel removal** Such as closing gas valves when fires occur.



Check Your Understanding

Explain why a bucket filled with sand is found in school laboratories.

.....



Research Activity

Search in multiple knowledge sources about instructions of using fire extinguishers.

Oxidation and Reduction

Combustion reactions are described as **oxidation-reduction reactions (Redox reactions)**.

What is meant by oxidation-reduction reactions (Redox reactions)?

Can an oxidation process occur without a reduction process?

- When a stream of air is passed over red-hot copper powder (Figure 16), copper combines with atmospheric oxygen forming black copper oxide. In this reaction, copper undergoes an **oxidation** process and is known as a **reducing agent**.

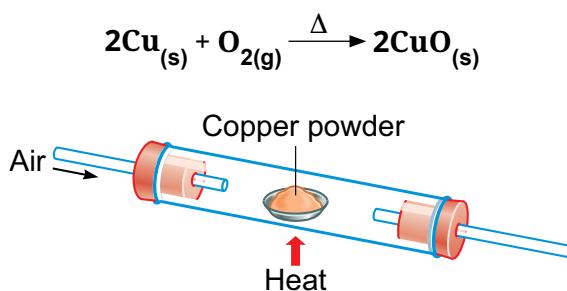


Figure (16)

- When a stream of hydrogen gas is passed over heated black copper oxide (Figure 17), reddish-brown copper is formed. In this reaction, copper oxide undergoes **reduction** process and is known as an **oxidizing agent**.

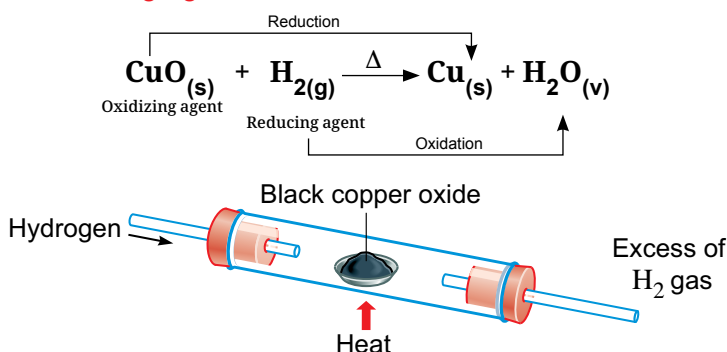


Figure (17)

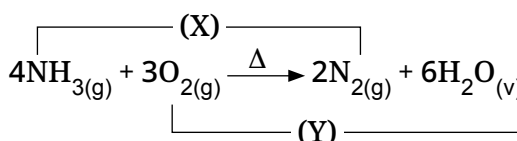
Based on the above, it is concluded that:

- **Oxidation:** A chemical process in which the percentage of oxygen increases or the percentage of hydrogen decreases in a substance.
- **Reduction:** A chemical process in which the percentage of oxygen decreases or the percentage of hydrogen increases in a substance.
- **Reducing agent:** Is the substance that donates (gives) hydrogen to, or takes oxygen away from another substance during a chemical reaction.
- **Oxidizing agent:** Is the substance that donates (gives) oxygen to, or takes hydrogen away from another substance during a chemical reaction.
- **Oxidation and Reduction:** are simultaneous processes occur at the same time.



Check Your Understanding

Ammonia gas undergoes incomplete combustion in air according to the equation:



Identify each of the following:

- 1- The process (X) that nitrogen (N_2) undergoes:
- 2- The process (Y) that oxygen (O_2) undergoes:
- 3- The Oxidizing agent:
- 4- The Reducing agent:



Technological Application

Food preservation by Air evacuation

Providing a poor-oxygen environment minimizes oxidation-reduction reactions which lead to spoiling of food. (Figure 18).



Figure (18)

Meat preserved in an vacuum-sealed bag

Assessment of Lesson Three



1 Choose the correct answer for questions (1) - (4).

(1) Each of the following represents an element of the fire triangle, except _____

- (a) heat (b) water
(c) fuel (d) oxygen

(2) Which choice of the following is correct?

Choice	Flammable gas	Gas assists burning	Gas neither burns nor assists burning
(a)	H ₂	CO ₂	O ₂
(b)	O ₂	H ₂	CO ₂
(c)	O ₂	CO ₂	H ₂
(d)	H ₂	O ₂	CO ₂

(3) Which fuel of the following has the highest calorific value?

- (a) Natural gas. (b) Ethanol.
(c) Hydrogen. (d) Wood.

(4) Which of the following describes the reaction of potassium permanganate with glycerin?

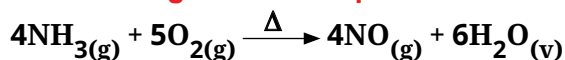
- (a) Endothermic and spontaneous ignition reaction.
(b) Exothermic and spontaneous ignition reaction.
(c) It occurs by heating although it is exothermic.
(d) It occurs by cooling although it is endothermic.

2 Mark a (✓) or (✗) in front of the following statements, and correct what is wrong.

- (1) Butagas is a mixture of methane and propane gases. ()
(2) Nitrogen gas is described as the fuel of the future. ()
(3) Bunsen flame changes colour according to the amount of oxygen mixed with the fuel. ()

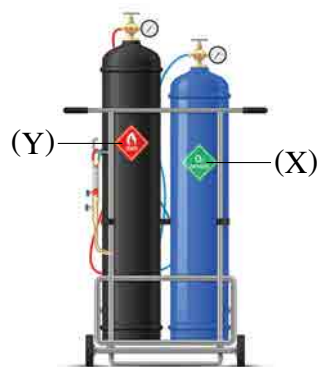
(4) The oxidizing agent undergoes a reduction process. ()

3 Ammonia burns completely in excess of oxygen gas according to the following balanced equation:



- (1) Identify the substances that undergo oxidation and those that undergo reduction.
(2) What is the reducing agent in this reaction?
(3) Write a balanced equation for the incomplete combustion of ammonia.

4 The figure shows a cylinder (X) containing a compressed gas that helps burning, and a cylinder (Y) containing a compressed flammable gas. Their mixture can produce a flame used in welding metals.



- (1) Name the gases in cylinders (X) and (Y).
(2) What is the name of the flame produced? What is its temperature?

5 How can understanding of oxidation and reduction help in preservation of food?

6 Is water or sand used to extinguish sodium fires?

Explain your answer.

UNIT 2

Forces and Motion

Unit lessons

Lesson one : Newton's Laws of Motion

Lesson two : Levers



Learning Outcomes :

By the end of this unit, students will be able to:

1. Appreciate the contributions of the Scientist Newton in physics.
2. Understand Newton's First Law.
3. Demonstrate the existence of balanced forces (Newton's First Law).
4. Understand Newton's Second Law.
5. Explain the relationship between force, mass, and acceleration (Newton's Second Law).
6. Understand Newton's Third Law.
7. Apply Newton's Third Law to collisions between two moving objects, or between a moving object and a stationary one.
8. Understand what the term "lever" means.
9. Apply the different types of levers to examples from everyday life.

Lesson One

Newton's Laws of Motion



Lesson Terminology:

- Newton's Laws of Motion.
- Inertia.
- Air Hockey.
- Kinematics.
- Net Force.
- Balanced Forces.
- Unbalanced Forces.
- Cruise Control.
- Acceleration.
- Seat Belt.
- Airbag.
- Action and Reaction.
- Elastic Collision.
- Inelastic Collision.
- Flyboard.
- Drone.
- Bocce Ball.



Included Skills, Values, and Issues :

- **Skills** : Cognitive - Mathematics.
- **Values** : Self-Preservation - Cooperation.
- **Issues** : Traffic safety and reducing road accidents.



Cross-Cutting Concepts :

- Cause and Effect.



Lesson Objectives :

By the end of the lesson, students will be able to :

- 1 Understand Newton's Laws of Motion.
- 2 Differentiate between balanced and unbalanced forces.
- 3 Explain the relationship between inertia and the mass of objects.
- 4 Solve problems related to Newton's Second Law.
- 5 Explain safety requirements when driving cars.
- 6 Apply Newton's Third law practically
- 7 Differentiate between elastic and inelastic collisions.
- 8 Explain some applications of Newton's laws in daily life.



Lesson Introduction :

The figure shows an empty cart.

This lesson explores ideas that will help you answer the questions below :

- When does this stationary cart move?
- Is there a relationship between the force causing the cart motion and its mass?
- Does the cart exert a force on the person pushing it?



Exploring the relationship between force and motion dates back to ancient times, when **Aristotle** believed that objects would not continue in motion unless a force acted continuously on them. **Galileo** later demonstrated that this belief was inaccurate by carrying out an experiment from which he concluded that objects tend to maintain their state of rest or motion unless acted upon by an external force (Figure 1). This property was later termed **inertia**.

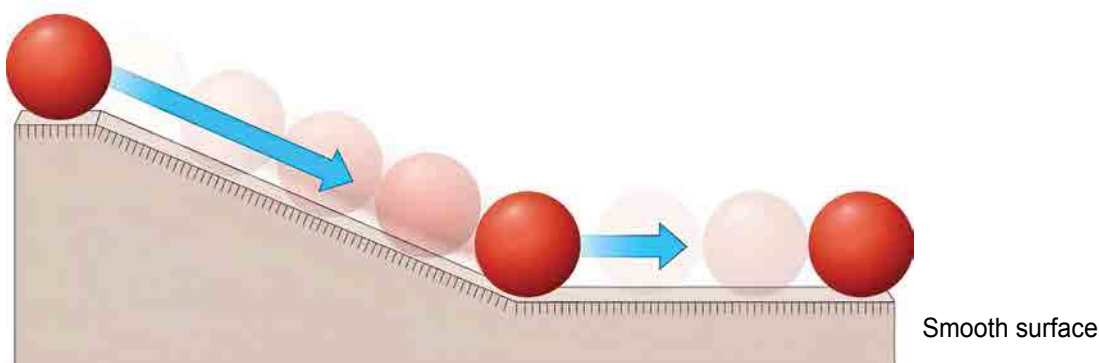


Figure (1)

The ball remains in motion unless acted upon by an external force.

- What laws govern the motion of objects?

Newton's Laws of Motion

Newton's Laws of Motion are the foundation of studying **kinematics**. These laws are expressed in simple mathematical formulas to study the causes of motion.

The Scientist Profile:

Isaac Newton

An English scientist who is considered one of the most influential scientists in physics and mathematics over ages, and a key figure of the scientific revolution.

He had significant contributions in optics. Also, he formulated the laws of motion and the universal law of gravitation, that dominated scientists' view of the universe until they were refined by the theory of relativity. He developed a theory of colours based on his observations when he used a prism to analyze white light into colours of the visible spectrum.

Besides, he formulated an empirical law for the cooling process, and studied the speed of sound in air.



Figure (2)

Scientist Isaac Newton

- Before studying Newton's laws of motion, it is essential to understand some concepts related to force, such as: **net force**, **balanced forces**, and **unbalanced forces**.

Net Force

- **Force** is a vector physical quantity that is fully defined by its magnitude and direction. It is measured in the unit of **newton (N)** (Figure 3) and by using a **Newton meter device (spring balance)** (Figure 4).
- When a number of forces act on an object, the total resulting force, in magnitude and direction, is called the net force. **The net force** determines whether the object will move, stop, or change its speed or direction. The forces acting on an object may be **balanced** or **unbalanced**.

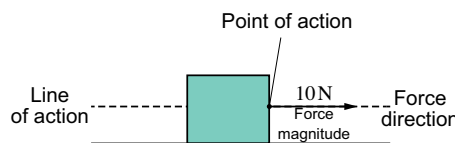


Figure (3)

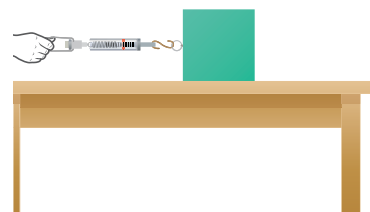


Figure (4)

Newton meter -
a device for measuring force

Balanced Forces and Unbalanced Forces

- When two forces of equal magnitude act on an object in opposite directions, along the same line of action, the net force on the object is the result of their difference, which equals zero. Such forces are called **balanced forces** (Figure 5).
- When several forces act on an object and their resultant is not equal to zero, they are called **unbalanced forces**, as indicated in the following two cases:

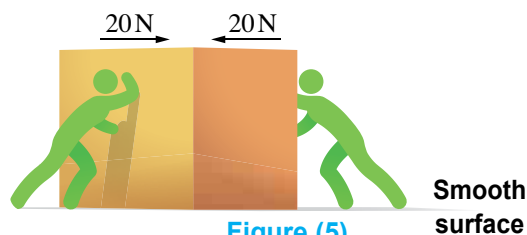


Figure (5)

Balanced forces whose
resultant equals zero

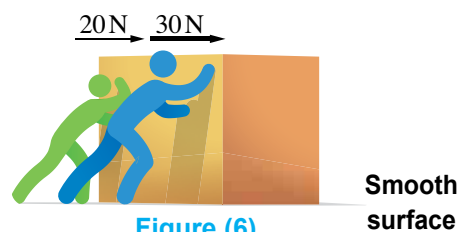


Figure (6)

Unbalanced forces whose resultant
equals 50 N to the right

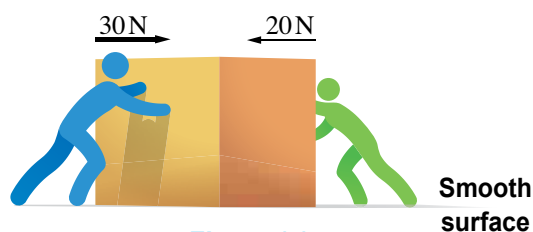


Figure (7)

Unbalanced forces whose resultant
equals 10 N to the right

- An object is acted upon by two forces in the same direction along the same line of action (Figure 6). The net force in this case is **equal to their sum and acts in their common direction**.
- An object is acted upon by two **unequal forces** in opposite directions along the same line of action (Figure 7). The net force in this case is **equal to their difference** and acts **in the direction of the greater force**.

Newton's First Law

Activity 1 Observe and conclude

① Why does the bag on the table remain stationary (Figure 8)?

.....

② What condition should be met for that bag to move?

.....

③ Does the box placed on the car roof (Figure 9) seem to be moving at the same velocity of the car, relative to an observer “a person” standing on the sidewalk, or does it seem stationary?

.....

④ What happens to the box when the car suddenly stops? (Figure 10)

.....

⑤ What do you conclude?

.....

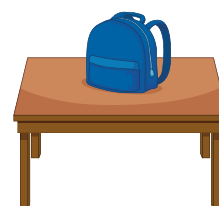


Figure (8)

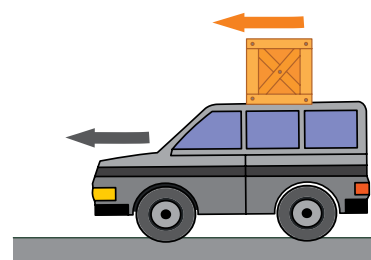


Figure (9)

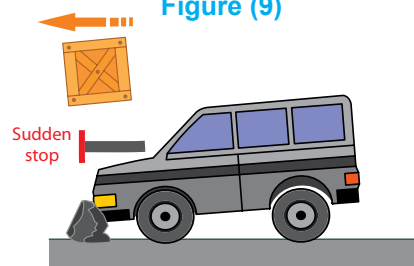


Figure (10)

Based on the above, it is clear that :

- When an object is at rest and is acted upon by **balanced forces**, it remains at rest (Figure 8). On the other hand, when an object which is moving at constant velocity in a straight line is acted upon by balanced forces, it continues moving at **the same constant velocity** (Figure 9).
- The box placed on the car (Figure 9) is moving at the same velocity as the car relative to an observer standing on the sidewalk.
- When a moving car suddenly stops, the box continues moving forward (Figure 10), due to its tendency to keep its state of motion for a certain period.

That can be summarized as: “An object keeps its state of rest, or state of motion at constant velocity in a straight line unless acted upon by **unbalanced external forces**”.

This is the statement of **Newton's First Law**, which is known as **Law of Inertia**.

Inertia can be observed when bus passengers tend to move forward upon sudden bus stop (Figure 11). This happens because the passengers' inertia causes them resist the sudden change in their kinematic state as the brakes are applied, trying to keep the state of motion they were in.

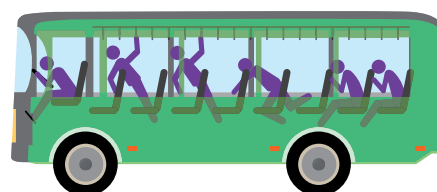


Figure (11)



Check Your Understanding

Figure (12) shows a group of forces acting on a stationary object:

(1) What is the resultant of these forces?

.....

(2) Will the object remain stationary, or will it move?

Explain your answer.

.....

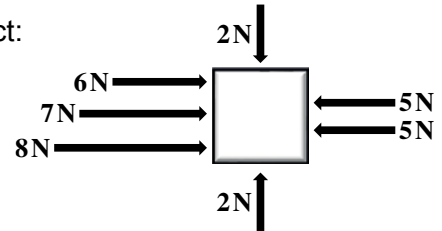


Figure (12)

Relation between the Inertia of an Object and its Mass



Activity 2 Analyze and Conclude

Study figure (13). The vertical axis represents the velocity of three vehicles, several times and each time they have the same velocity. The horizontal axis represents the distance each vehicle travels after pressing the brakes, which is known as **the stopping distance**

Cooperate with your classmate to answer the following questions:

① **Arrange** the vehicles in an ascending order **according to**:

- Their mass:
- Their stopping distance:

② **What is the relationship between** the stopping distance of a vehicle and its mass when using the brakes?

.....

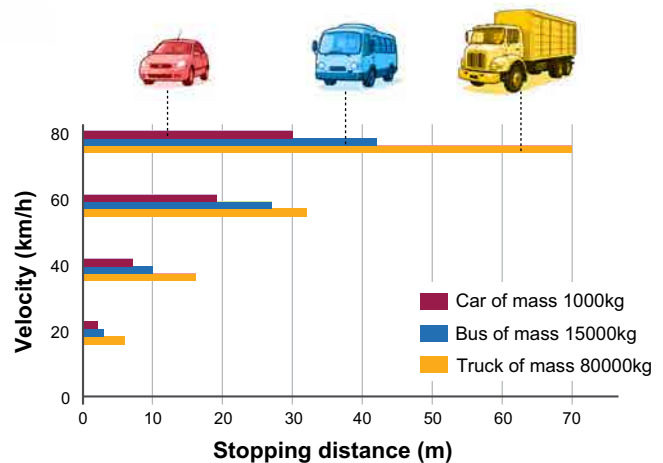


Figure (13)

Based on the above, it is concluded that :

- The greater the mass of an object, the greater its inertia. It is indicated by the increased time it tends to keep its state of motion; consequently, both the stopping time and stopping distance increase.



Cross-Cutting Concepts : Cause and Effect

An increase in the object mass and consequently in its inertia (**Cause**), makes it harder to stop when in motion and harder to move when at rest (**Effect**).



Check Your Understanding

In the figures:



Figure (14)



Figure (15)

- (1) What happens when the electric current flowing to the fan circuit is switched off (Figure 14)?

Explain your answer.

.....

- (2) What happens when a tablecloth is pulled quickly from under a fruit plate (Figure 15)?

Explain your answer.

.....



Technological Applications

1 Cruise Control

A device is used to keep the car moving - without direct intervention from the driver- at a constant velocity on highways (Figure 16). This is achieved via sensors that control pumping the fuel at the proper rate that keeps the forces acting on the car balanced.



Figure (16)

Cruise control

2 Air Hockey

A fun game in which circular paddles are used to push a light disc sliding on a smooth table with holes through which a continuous stream of air is pushed, reducing friction between the disc and the table, allowing the disc to maintain its state of motion for a longer period (Figure 17).



Figure (17)

Air hockey table

Newton's Second Law

Newton's First Law explains that the net force acting on an object is the cause of changing its state of rest or motion. The Second Law will explain the effect of the net force on changing the velocity of an object over time.

Activity 3 Analyze and Conclude

Figure (18) shows the motion of a car on a straight road:

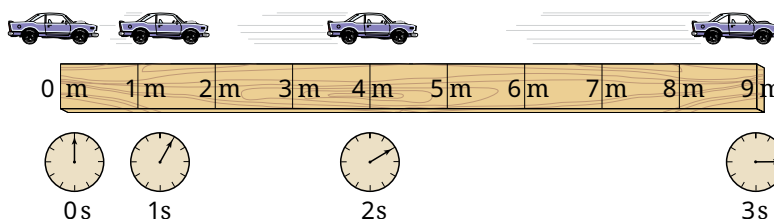


Figure (18)

Motion with an acceleration

Table (1)

- ① **Determine** the distance the car covers and the car velocity, then fill in the blanks in Table (1).
- ② **Does** the car move at constant velocity?
.....

Time Interval (s)	Time	Distance covered	Average Velocity = $\frac{\text{Distance}}{\text{Time}}$
0 – 1			
1 – 2			
2 – 3			

- When the object velocity increases or decreases during motion, the change in velocity per unit time, or the time rate of change of velocity, is known as **acceleration** and denoted by symbol (**a**).

Newton's Second Law states that: "If a net force (**F**) acts on an object of mass (**m**), it causes it to accelerate at an acceleration (**a**) in the same direction as the net force.

Newton's Second Law is mathematically expressed as

$$\text{Acceleration (a)} = \frac{\text{Net Force (F)}}{\text{Mass (m)}}$$

Units of measurement:

- Force: The newton (N).
- Mass: The kilogram (kg).
- Acceleration: Newton/kilogram (N/kg)
which is equivalent to meter/second² (m/s²).

► **Force and acceleration** are vector physical quantities, while **mass** is a scalar physical quantity that is fully defined by its magnitude only.

Mathematical Understanding

- Calculate the net force acting on a car of mass 1200 kg moving at an acceleration of 3 m/s².

$$\therefore F = m \times a$$

$$\therefore F = 1200 \times 3 = 3600 \text{ N}$$

Activity 4 Observe and conclude

① In Figure (19), in which case the cart will move at a lower acceleration?

② In Figure (20), in which case the cart will move at a higher acceleration?



Case (1)



Case (2)

Figure (19)



Case (1)



Case (2)

Figure (20)

Based on the above, it is concluded that :

- The acceleration at which an object moves **increases** as the net force acting on it increases, at constant mass.
- The acceleration at which an object moves **decreases** as the mass of the moving object increases, "keeping the net force acting on it constant".

Figure (21) is a graphical representation of the relationship between the acceleration (a) at which an object moves (the dependent variable) and the net force (F) acting on it (the independent variable).

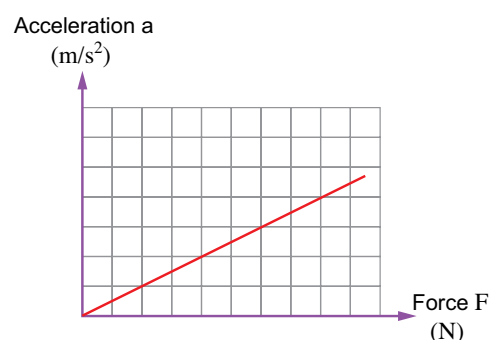


Figure (21)



Check Your Understanding

- Based on your understanding of Newton's Second Law, fill in the blank cells in Table (2).

Table (2)

Independent Variable	Dependent Variable	Controlled Variables
.....		Force
Force		

Safety Precautions

► According to Newton's First Law (Law of Inertia), when a car suddenly stops, the driver will be forced forward and may hit the steering wheel or windshield. Upon crash, **the seat belt** reduces the forward thrust of the driver towards the steering wheel. It works together with **the airbag** to prolong the time of collision.

Consequently, they reduce the rate of change of velocity, which in turn minimizes the impact of collision on the driver's body (Figure 22).

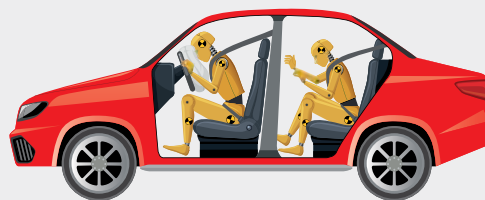


Figure (22)

Importance of the seatbelt and airbag

Newton's Third Law

Figure (23) shows two girls sitting on skateboards on a smooth surface. Describe the direction of motion of each girl after pushing their feet against each other.

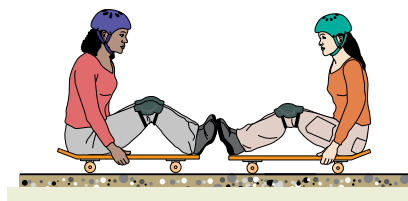


Figure (23)

Activity 5 Practical Work

Materials and Tools

- Fishing line.
- Juice straw.
- Binder clip (clothes clip).
- Adhesive tape.
- Balloon.

Steps :

- 1 Fix one end of the fishing line to the door handle.
- 2 Pass the free end of the line through the juice straw.
- 3 Stretch the line and fix its free end firmly to a rigid object.
- 4 Inflate the balloon and close its opening using the binder clip.
- 5 Attach the balloon to the juice straw using the adhesive tape.
- 6 Remove the clip from the balloon opening.

- **What happens** when the air is released from the balloon to the left side (Figure 24)?

- **What is the colour of the** arrow that represents each of
- Action force?

- Reaction force?

- **Can** the balloon rush without releasing air from it?

- **Is** there any time difference between the actions of the two forces?

- **What** is the relation between the directions the two forces?

- **Do** the two forces act on one object **or** two objects?

In this activity, the action is the force of air rushing out of the balloon, while the reaction is the push of the balloon in the opposite direction to the blowing air. **Action** and **reaction** always occur without any time difference.

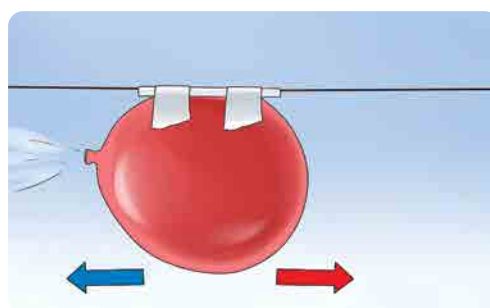


Figure (24)

Newton's Third Law states that “For every action, there is an equal and opposite reaction” (Figure 25).

You may wonder, why the action and the reaction **don't cancel** out the effect of each other although they are equal in magnitude and opposite in direction.

In other words, why is no equilibrium achieved?

When two forces that are equal in magnitude, opposite in direction and have the same line of action act on one object, they balance each other according to Newton's First Law.

But, according to Newton's Third Law, in the case of action-reaction pair, the two forces act on **two different objects**.

So, they do not cancel the effect of each other.

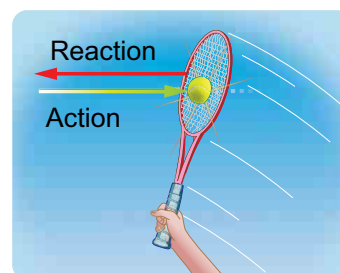


Figure (25)

Reaction direction is opposite to action direction

The Effect of Collisions on Velocity Change

When two **equal-mass** objects that are moving at the **same velocity in opposite directions** collide with each other, (assuming no loss in kinetic energy on collision), both will move in the opposite direction with the same velocity (Figure 26). Each object acquires acceleration due to the change of its direction. The direction of acceleration is the same as that of the net force acting on it.



Figure (26)

Collision between two equal-mass objects moving at the same velocity, in opposite directions

When **a moving object** collides with **a stationary one** of the same mass, the two objects are affected by two forces equal in magnitude and opposite in direction.

A number of possibilities are expected that may include:

- The moving object stops (comes to rest), meanwhile the stationary object moves at the same velocity as that of the moving object before collision (Figure 27).

Such collision is described as an **elastic collision** since no loss in kinetic energy occurs.

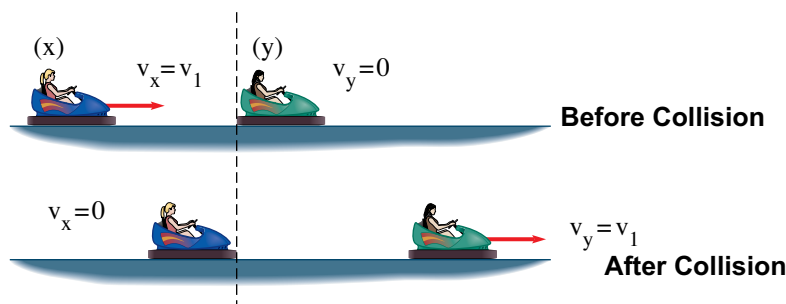


Figure (27)

Elastic collision

- The moving object **slows down**, and the stationary object **moves**. Both objects will move together at a velocity equal to half that of the moving object before collision (Figure 28). Such collision is known as an **inelastic collision**. The loss in kinetic energy is converted into heat, sound, or work done as the shape is deformed.

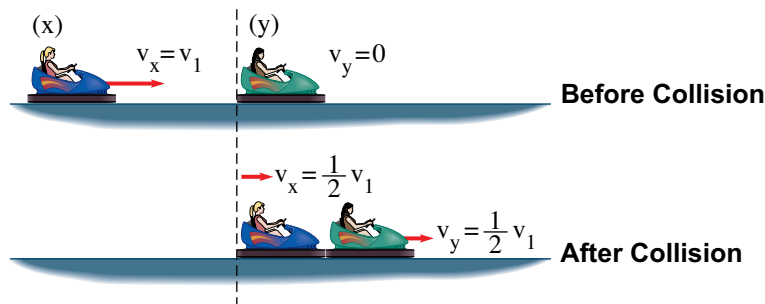


Figure (28)
Inelastic collision



Life Application

Flyboard

Allows the person to fly upwards (reaction) as water is strongly pumped out downwards (action) through the board nozzles (Figure 29).



Figure (29)
Flyboard



Technological Application

Unmanned Aerial Vehicles (Drones)

Operate by pushing air downwards from the engines (action) which results in an equal upward push by the air on the drone (reaction) (Figure 30).



Figure (30)
Drone



Research Activity

Search various knowledge sources, including the internet, for the sport of Bocce ball and how it is related to Newton's Laws of Motion.



Issue for Discussion

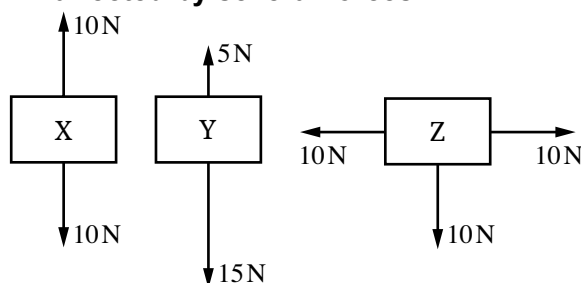
Traffic safety and limiting road accidents.

Assessment of Lesson One



1 Choose the correct answer for the questions (1) - (5).

- (1) A net force of 1 N means an object of mass 1 kg is
 - (a) moving at an acceleration of 10 m/s^2 .
 - (b) moving at an acceleration of 1 m/s^2 .
 - (c) lifted vertically at a velocity of 1 m/s .
 - (d) lifted vertically at a velocity of 10 m/s .
- (2) An object moves at an acceleration (a). If the object mass is halved and the net force acting on it is doubled, its acceleration of motion will be
 - (a) a (b) 2a (c) 3a (d) 4a
- (3) Which of the following bodies has the greatest inertia?
 - (a) A ball of mass 0.1 kg moving at velocity 50 m/s .
 - (b) A runner of mass 70 kg moving at velocity 30 m/s
 - (c) A car of mass 1000 kg moving at velocity 50 m/s
 - (d) A van of mass 2000 kg moving at velocity 30 m/s
- (4) The figures below show three objects X, Y, Z. Each object is affected by several forces:



Which object is affected by a non-zero net force (unbalanced forces) ?

- (a) Objects X, Y, Z. (b) Object X only
 - (c) Objects Y and Z only
 - (d) Object Y only
- (5) Launching a rocket in a direction opposite to that of the expelled gases is explained by:
- (a) Newton's First Law.
 - (b) Newton's Second Law.
 - (c) Newton's Third Law.
 - (d) Law of Universal Gravitation.

- (2) Calculate the acceleration at which a car of mass 1000 kg moves when the engine force is 1300 N (ignoring friction force affecting the car).

3 What happens :

- (1) to the acceleration of a moving object when its mass increases while the force acting on it remains constant?
- (2) when two equal-mass objects, moving at the same velocity in opposite directions collide with each other?

4 Explain the following observations:

- (1) When a person standing at the front of a small boat jumps forward, the boat moves backward.
- (2) Passengers in a stationary bus are pushed backward when it suddenly starts moving.

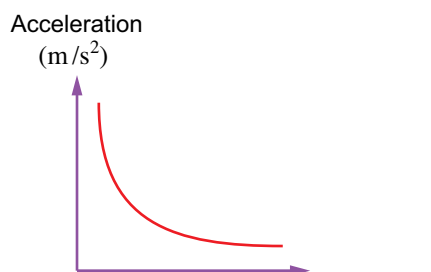
5 Mention four characteristics that describe the two forces mentioned in Newton's Third Law.

- (6) What happens when an elastic collision occurs between two identical balls, one is moving and the other is stationary?

- (7) Which takes less time to stop when applying the brakes: A truck or a car moving at the same velocity? Explain your answer.

8 Based on your understanding of Newton's Second Law:

What does the horizontal axis represent in the given graph?



Lesson Two

Levers



Lesson Terminology:

- Simple Machines.
- Pulley.
- Inclined Plane (ramp).
- Wheel and Axle.
- Wedge.
- Gears and Belts.
- Lever.
- Effort (E).
- Load (L).
- Fulcrum (F).
- Mechanical Advantage.
- First-Class Lever.
- Second-Class Lever.
- Third-Class Lever.



Included Skills, Values and Issues :

- **Skills** : Cognitive – Practical – Mathematical.
- **Values** : Respect manual labor.
- **Issues** : The impact of using machines on man's physical abilities and manual skills.



Cross-Cutting Concepts:

- Cause and Effect.



Lesson Objectives :

By the end of the lesson, students will be able to:

- 1 List the types of simple machines.
- 2 Understand the concept of a lever.
- 3 Verify the law of levers practically.
- 4 Calculate the mechanical advantage of levers.
- 5 Differentiate between types of levers.
- 6 Give examples of levers and their types in the human body.



Lesson Introduction :

The figure shows a staple remover.

This lesson explores ideas that will help you answer the questions below.

- Does this tool save effort?
- What are the three factors that define the operation of this tool?
- Is this tool considered simple or complex?



- **Can** workers lift the concrete blocks used in constructing huge buildings with their bare hands; without using the tower crane shown in Figure (1)?
- Technological progress has led humans to use machines to perform most tasks, though this does not diminish the importance of the human element, especially in simple manual tasks. The tower crane is a **complex** machine consisting of many **simple** machines.



Figure (1)
Tower crane (winch)

Simple Machines

Figures (2) - (9) show simple machines and the purposes of their use.

Levers



Figure (2)

A claw hammer multiplies force when removing a nail from a wooden board.



Figure (3)

Tweezers are used in precise work.



Figure (4)

Barbecue tongs are used to avoid the risk of burning.

Pulley



Figure (5)

The pulley changes the direction of force when lifting a load.

Inclined Plane (Ramp)



Figure (6)

The ramp is used to save effort.

Wheel and Axle

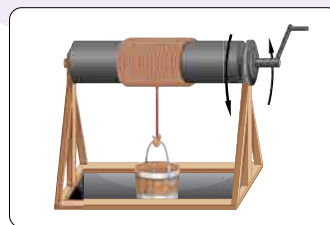


Figure (7)

Wheel and axle multiply force or increase speed.

The wedge



Figure (8)

The wedge changes the direction of the applied force.

Gears and belts



Figure (9)

Gears and belts transfer motion and change speed as in bicycles.

We will limit our scope of study to levers as an example of simple machines.

Levers

Activity 1 Observe and conclude

Figures (10) - (12) demonstrate three examples of levers.



Figure (10)



Figure (11)



Figure (12)

Tick (✓) the statement that can express a common feature in these levers.

- | | |
|---|-----|
| ① They are similar in shape and size. | () |
| ② Their work begins with the action of external forces. | () |
| ③ All are pivoted on a fixed point. | () |
| ④ All are characterized by being rigid | () |

Based on the above, it is concluded that :

A **lever** is a rigid rod, either straight or curved, that is pivoted on (can move around) a fixed point called **the fulcrum (F)**. When using a lever, two forces act upon it; **the effort (E)** and **the resistance or the load (L)**.

Usually, the resistance is a load that is moved by the effort force and the fulcrum is the point around which the lever can rotate (Figure 13).

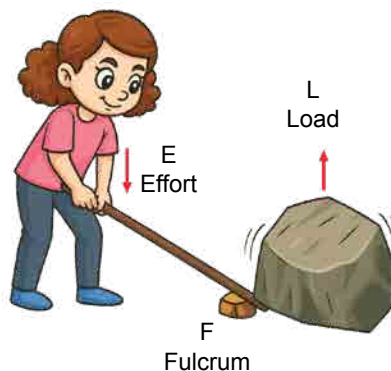


Figure (13)

Elements of a lever



Issue for Discussion

The effect of using machines on human physical abilities and manual skills.

Law of Levers



Activity 2 Practical Work

- ① Hang a load at 2 cm to the right of the fulcrum of a beam balance.
What do you observe?
.....
- ② Hang a similar load at 5 cm to the left of the fulcrum (Figure 14).
What do you observe?
.....
- ③ Move the load on the right to be 5 cm from the fulcrum.
What do you observe?
.....



Figure (14)
Beam balance

The distance between the load and the fulcrum is known as the **load arm**, and the distance between the applied force (effort) and the fulcrum is known as the **effort arm** (Figure 15).

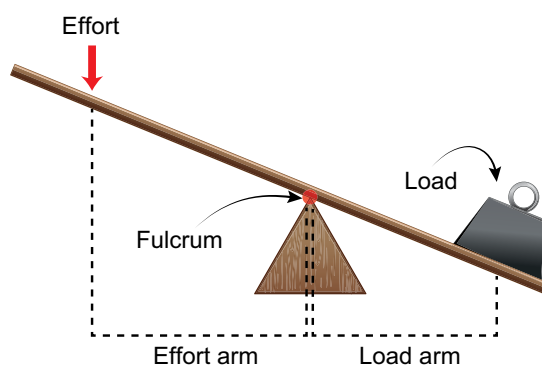


Figure (15)

The lever is at **equilibrium** when the product of the Effort and its Arm equals the product of Load and its Arm (Figure 16). This relation is known as “**Law of Levers**”.

The product of the Effort and its Arm is called **Moment of Effort**.

The product of the Load and its Arm is called **Moment of Load**.

Thus, the lever is balanced when **the moment of effort** equals **the moment of load**.

Law of Levers

$$\text{Effort} \times \text{Effort Arm} = \text{Load} \times \text{Load Arm}$$

"Moment of Effort" "Moment of Load"

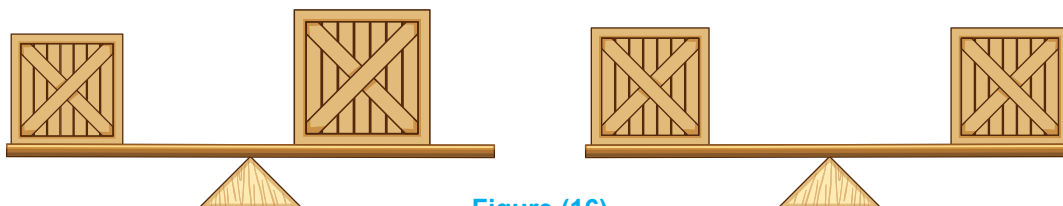


Figure (16)
Balanced levers

The extent to which the lever saves effort is determined by its **mechanical advantage**, which is estimated from the following relation:

$$\text{Mechanical Advantage of Lever} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{Length of Effort Arm}}{\text{Length of Load Arm}}$$

The machine saves effort when its mechanical advantage is greater than 1.



Cross-Cutting Concepts : Cause and Effect

Increasing the length of the effort arm (cause),
leads to reducing the needed force to lift the same load (effect).

Mathematical understanding

- In a lever, a load of mass 2 kg is suspended at 15 cm to the right of the fulcrum. To balance the lever horizontally, another load of weight 30 N that represents the resistance is suspended at a distance (x) cm to the left of the fulcrum.

[Gravitational acceleration = 10 m/s²]

Calculate:

- (1) The value of (x).
- (2) The mechanical advantage of this lever.

Solution:

$$\begin{aligned} \text{Weight of load (force)} &= \text{mass} \times \text{acceleration due to gravity} \\ &= 10 \times 2 = 20 \text{ N} \end{aligned}$$

$$(1) \because \text{Effort} \times \text{its arm} = \text{Load} \times \text{its arm}$$

$$20 \times 15 = 30 \times (x)$$

$$\therefore \text{Load arm (x)} = \frac{20 \times 15}{30} = 10 \text{ cm}$$

$$(2) \because \text{Mechanical Advantage of Lever} = \frac{\text{Magnitude of Load}}{\text{Magnitude of force}}$$

$$\therefore \text{Mechanical Advantage} = \frac{30}{20} = 1.5$$

Cumulative knowledge

- The weight of a body is the force of Earth's gravity acting on it
Weight (w) = Mass (m) × Acceleration due to gravity (g)



Check your understanding

Which of the two cases shown in Figure (17) saves more effort? Explain your answer.

.....

.....

.....

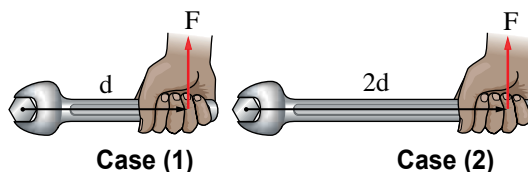


Figure (17)

Types of Levers

There are three types of levers. The type and importance of each lever are determined by the relative positions of the effort, load and fulcrum.

Activity 3 Discover

Figures (18) - (20) represent the three types of levers. Positions of the effort, load, and fulcrum are indicated by arrows of different colours

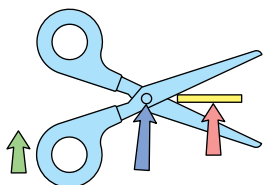


Figure (18)

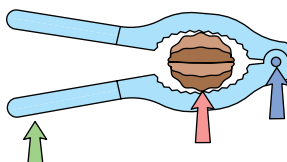


Figure (19)

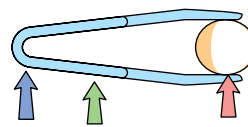


Figure (20)

- ① What does each of the following represent?
 - Green arrows :
 - Red arrows :
 - Blue arrows :
- ② Determine which element (Effort / Load / Fulcrum) is located between the other two elements in the lever shown in:
 - Figure (18) : is located between and
 - Figure (19) : is located between and
 - Figure (20) : is located between and
- ③ In which of these figures:
 - Length of effort arm > Length of load arm
 - Length of load arm > Length of effort arm

• Therefore, it is clear that: there are three types of levers, namely :

First-Class Lever

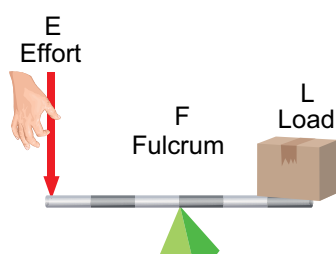


Figure (21)

Example

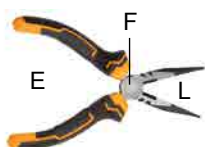


Figure (22) Pliers

Second-Class Lever

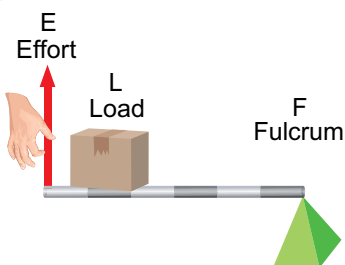


Figure (23)

Example



Figure (24) Lemon squeezer

Third-Class Lever

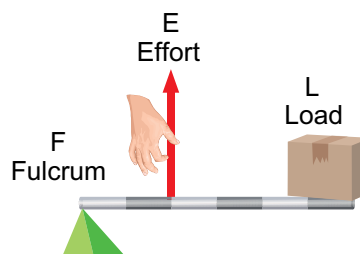


Figure (25)

Example



Figure (26) Tweezers

- **First-Class Levers** (Figure 21): The fulcrum is located between the effort and the load.

Examples : Seesaw, Crowbar, Scissors, and Pliers (Figure 22).

All first-class levers change direction of **force**, but some save effort and others do not.

- **Second-Class Levers** (Figure 23): The load is located between the fulcrum and the effort.

Examples : Wheelbarrow, Nutcracker, and Lemon Squeezer (Figure 24).

All second-class levers save effort, because the effort arm is always longer than the load arm.

- **Third-Class Levers** (Figure 25): The effort is located between the fulcrum and the load.

Examples : Tennis Racket, Hand Broom, Tweezers (Forceps), and Coal Tongs (Figure 26).

All third-class levers never save effort but they are used in precise and dangerous tasks.



Scientific Skills:

The mechanical advantage of levers may be (1, greater than 1 or less than 1).

In terms of the mechanical advantage, classify the three types of levers.

Information and Communication Technology



You can perform an interactive simulation of levers and their three types using programs like PhET.



Integration with Biology

Bones forming the skeletal system are levers, and the joints around which bones move represent fulcrums. The contraction force of muscles represents the effort, while the forces to be overcome represent the resistance (load).

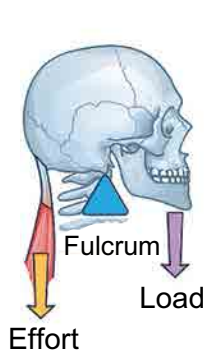


Figure (27)

The Head



Figure (28)

The Foot while standing on tiptoes

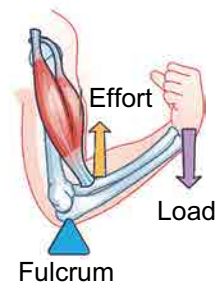


Figure (29)

The Forearm

- **The Head (a first-class lever)**

The point at which the skull meets the spine represents the fulcrum. The weight of the head, which needs to be balanced forward, is the load. The downward pull by the neck muscles to make the head balanced is the effort (Figure 27).

- **The Foot while standing on tiptoes (a second-class lever)**

The tips of the toes represent the fulcrum, the body weight represents the load, and the pull of calf muscles represents the effort (Figure 28).

- **The Forearm (a third-class lever)**

The elbow joint represents the fulcrum, the object held in the palm of the hand is the load, and the pull of biceps muscle is the effort (Figure 29).

Assessment of Lesson Two



1 Choose the correct answer for the questions (1) - (3).

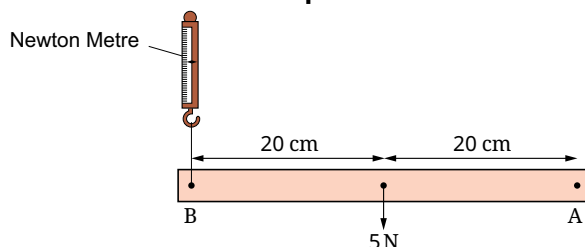
(1) When the lever is at equilibrium

- (a) Effort $\times$ load arm = Load $\times$ effort arm
- (b) Moment of effort $>$ Moment of load
- (c) Effort $\times$ its arm $>$ Load $\times$ its arm
- (d) Moment of effort = Moment of load

(2) Ice tongs

- (a) have a mechanical advantage equal to 1.
- (b) are a third-class lever.
- (c) have a mechanical advantage greater than 1.
- (d) are a second-class lever.

(3) A metal rod AB of weight 5 N is able to rotate around point A.



What is the reading of the Newtonmeter when the rod is balanced horizontally?

- (a) 2.5 N.
- (b) 5 N.
- (c) 8 N.
- (d) 10 N.

2 The weight of a wheelbarrow carrying sand is 900 N. If the distance from the wheel (fulcrum) to the center of gravity of wheelbarrow (load) is 0.4 m, and from the wheel to the hand position on the handle (Effort) is 1.2 m:

- (1) What is the lever type? Explain your answer.
- (2) Does the wheelbarrow save effort? Justify your answer mathematically.

3 From the two figures:



Figure (1)

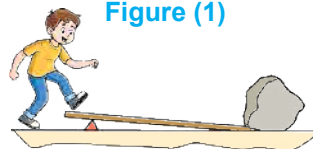


Figure (2)

Which figure represents a better way to lift the rock? Explain your answer. What can be done to increase the mechanical advantage of this lever?

4 The two figures below represent a type of levers:

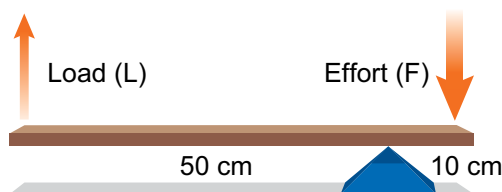


Figure (1)

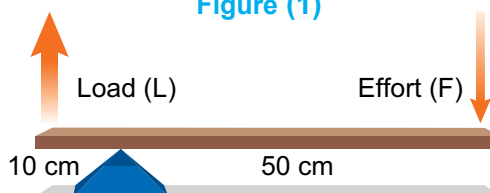


Figure (2)

- (1) What type of lever is this? Explain your answer.
- (2) Which figure represents the lever when it has a greater mechanical advantage? Find its value.

5 Classify the levers shown in the figures below in terms of their types:



Figure (1)

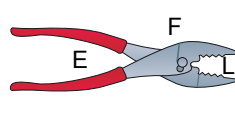


Figure (2)



Figure (3)

UNIT 3

Reproduction in Living Organisms

Unit Lessons

Lesson one : Cell Division.

Lesson two : Floral Reproduction.



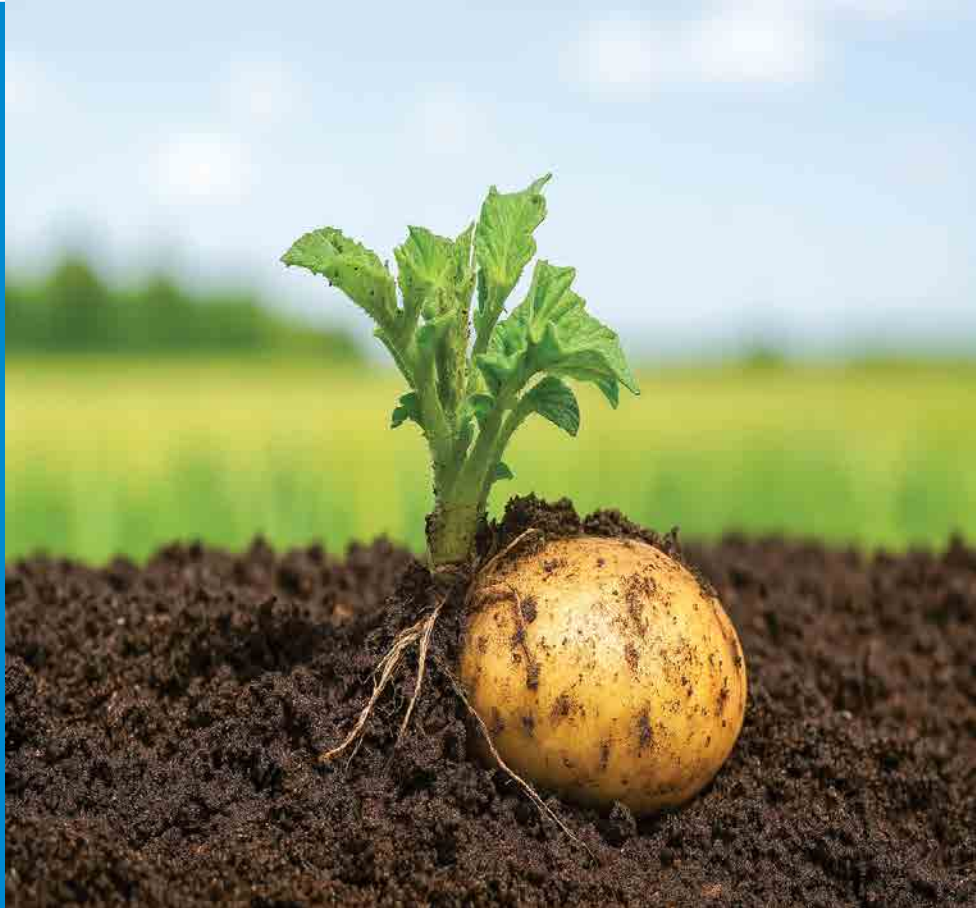
Learning Outcomes :

By the end of this unit, students will be able to:

1. Differentiate between mitosis and meiosis.
2. Explain the lack of genetic variation in individuals resulting from Asexual Reproduction and its variation in Sexual reproduction.
3. Explain Asexual reproduction.
4. Explain Sexual reproduction in the flower.
5. Describe the structural adaptation of the flower to perform its function.
6. Identify the function of pollination and fertilization in floral reproduction.
7. Explain pollination in the flower by wind and animals.

Lesson One

Cell Division



Lesson Terminology

- Somatic Cells
- Gametes
- Ovule
- Sperm
- Pollen Grains
- Asexual Reproduction
- Mitosis
- Cancerous Tumor
- Meiosis
- Gonads
- Zygote
- Fertilization
- Crossing Over



Included Skills, Values, and Issues :

- **Skills** : Practical - Cognitive - Mathematical.
- **Values** : Respecting diversity among individuals in the human species.
- **Issues** : Stem cell therapy.



Cross-Cutting Concepts :

- Structure and Function.



Lesson Objectives :

By the end of the lesson, students will be able to :

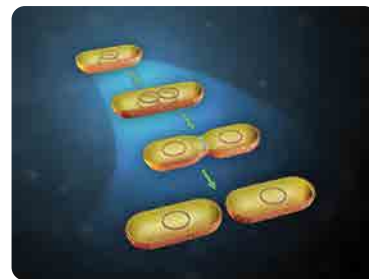
- 1 Distinguish between somatic cells and reproductive cells.
- 2 Distinguish between meiotic and mitotic divisions.
- 3 Distinguish between Asexual reproduction and Sexual reproduction.
- 4 Illustrate examples of forms of Asexual reproduction.



Lesson Introduction :

The figure shows the reproduction of a bacterial cell: This lesson explores the ideas that help you answer these questions :

- What is the difference between reproduction in bacteria and reproduction in humans?
- What type of division occurs in the bacterial cell?
- Is there another type of cell division?



The **cell** is the basic unit of structure and function in all living organisms. All living organisms share common characteristics such as **nutrition, respiration, sensation, movement, and reproduction**.

Reproduction is a vital biological process through which a living organism produces new individuals of the same species, ensuring the continuity of life and protecting the species from extinction.

So, how does reproduction occur in living organisms?

Living Cells

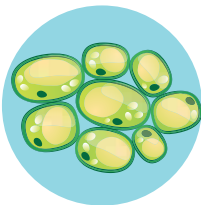
Reproduction in living organisms depends on the ability of cells to **divide**. Accordingly, cells in living organisms are classified into two main types:

- ① Somatic cells
- ② Reproductive cells

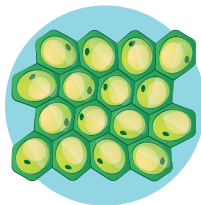
① Somatic cells

Somatic cells include all the cells of the organism except the reproductive cells.

Examples of somatic cells include **parenchyma** and **collenchyma** cells found in the stems and leaves of **plants** (Figure 1), as well as intestinal cells and cardiac (heart) muscle cells **in animals and humans** (Figure 2).



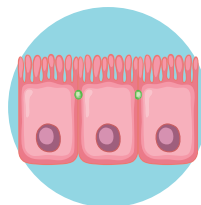
Parenchymal cells



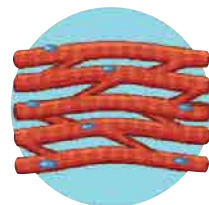
Collenchymal cells

Figure (1)

Somatic cells in plants



Intestinal cells



cardiac (heart) muscle cells

Figure (2)

Somatic cells in animals and humans

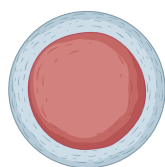
Somatic cells contain the full number of chromosomes in homologous pairs, represented by the symbol $(2n)$. Within a single species, chromosome number in somatic cells is always the same. Having the same chromosome count in somatic cells of different species does not mean that they are genetically similar. A chimpanzee and a potato plant both have 48 chromosomes (24 pairs), but their genetic information is entirely different. It is also important to note that chromosome count in cells does not determine the organism size; an elephant has 56 chromosomes, while a much smaller crow has 80 chromosomes.

2 Reproductive cells

Gonads (male and female reproductive organs) produce reproductive cells known as gametes, which are the specialized cells responsible for sexual reproduction in living organisms, as shown in Table (1).

Table (1)

The Living Organism	Gonads	Gametes	
Animal and human	Testes	Sperms	(Figure 3)
	Ovary	Ova	
Plant	Anther	Pollen grains	(Figure 4)
	Ovary	Ovules	



Ovum
(Female gamete)



Sperm
(Male gamete)

Figure (3)



Ovule
(Female gamete)



Pollen grain
(Male gamete)

Figure (4)

Gametes contain **half** the number of chromosomes found in somatic cells, therefore it is symbolized by (n).



Check Your Understanding

Complete Table (2) with the appropriate number of chromosomes:

Table (2)

The living organism	Number of chromosomes in				
	Somatic Cell	Ovum	Sperm	Pollen Grain	Ovule
Human	46	.....	.....		
Gorilla	.....	.....	24		
Pea	14			.....	.....
Wheat	.....			.....	21
Fruit fly	8	.....	.....		

Asexual Reproduction

Does reproduction in all living organisms **require** the presence of two individuals of different sexes, or can it occur by a single individual?

Activity 1 Practical Work

Materials and Tools

- Potato tubers.
- Agricultural soil.
- A cup of water.
- Toothpicks.
- Knife.
- Pot.

Steps :

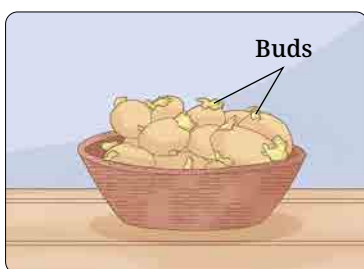


Figure (5)

Place the potato tubers that containing buds (eyes) in a humid medium until buds sprout.



Figure (6)

Use the knife to cut a potato tuber into two parts, each containing few buds.

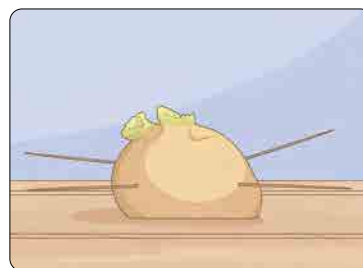


Figure (7)

Insert four toothpicks into each part of the tuber.

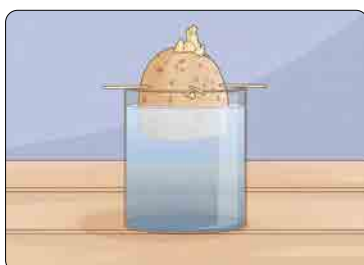


Figure (8)

Immerse the cut part of the tuber in a cup of water.

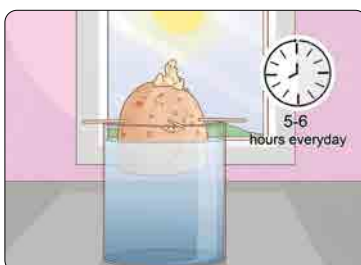


Figure (9)

Place the cup in sunlight until roots begin growing in the water.



Figure (10)

Transfer the potato pieces to the soil, so that the roots face downwards.

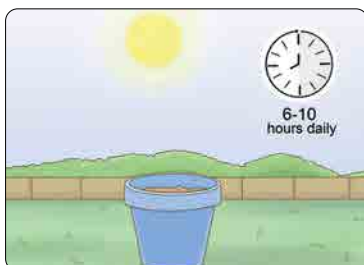


Figure (11)

Cover the pieces with soil, then expose the pot to sunlight for 6 -10 hours daily.



Figure (12)

When the plant leaves turn yellow, the potato tubers are ready to be harvested.



Figure (13)

Pull the stem from the soil and separate the potato tubers from each other.

• **Did** this reproduction occur through a single individual or two individuals of different sexes?

• **Is** this type of reproduction described as sexual or asexual?

• **What** are the characteristics of the cells resulting from this reproduction?

• Potato tubers represent a clear example of **vegetative reproduction**, which occurs through a single parent plant and is therefore classified as a form of **asexual reproduction**.

A single piece of a potato tuber that contains at least one bud is capable of developing into a new plant. When this tuber piece is placed under suitable environmental conditions, **the bud** becomes active and develops into a young stem that grows upward and produces leaves. At the same time, other cells of the bud differentiate to form primary roots that extend downward into the soil.

During the early stages of growth, the tuber functions as a storage organ, acting as an energy reservoir for the developing stem and roots, supplying them with stored nutrients and energy. As the roots grow and begin absorbing water and mineral salts from the soil, and the stem and leaves grow toward light, the new plant becomes capable of carrying out photosynthesis.

Cell Division

There are two types of cell division, **which are**:

First: Mitosis.

Second: Meiosis.

First

Mitosis

Why is mitosis known as **equational division** division?

Activity 2 Observe and Conclude

Figure (14) shows cell division occurring in a somatic cell.

① **How many** daughter cells are produced as a result of this division?

② **How many** chromosomes are present in each of the resulting cells?

③ **Do you expect** a difference in genetic information between:

- Cell (1) and cell (3):

- Cell (2) and cell (3):

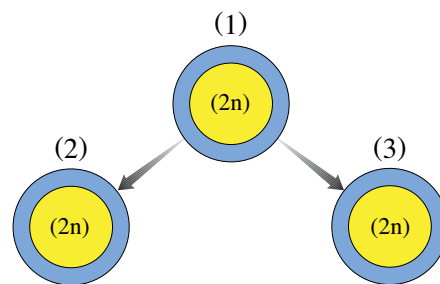


Figure (14)

- Mitosis is the type of cell division in which one diploid cell ($2n$) divides to produce two new diploid daughter cells ($2n$) that are genetically identical to the original cell. During this process, a complete and identical set of genetic information is equally distributed to each daughter cell. For this reason, mitosis is described as an **equational** division. Asexual reproduction depends on mitosis because it results in the formation of an exact genetic copy of the single parent individual.

In humans, mitosis serves several important functions, including:

- (1) Growth of the body.
- (2) Compensation for dead or damaged tissues, such as during wound healing and the repair of blood vessels, muscles, and bone fractures.

Integration with Medicine

- When a somatic cell begins to divide repeatedly in an uncontrolled and abnormal manner through mitosis, this leads to the formation of a cancerous (malignant) tumor, as shown in (Figure 15).

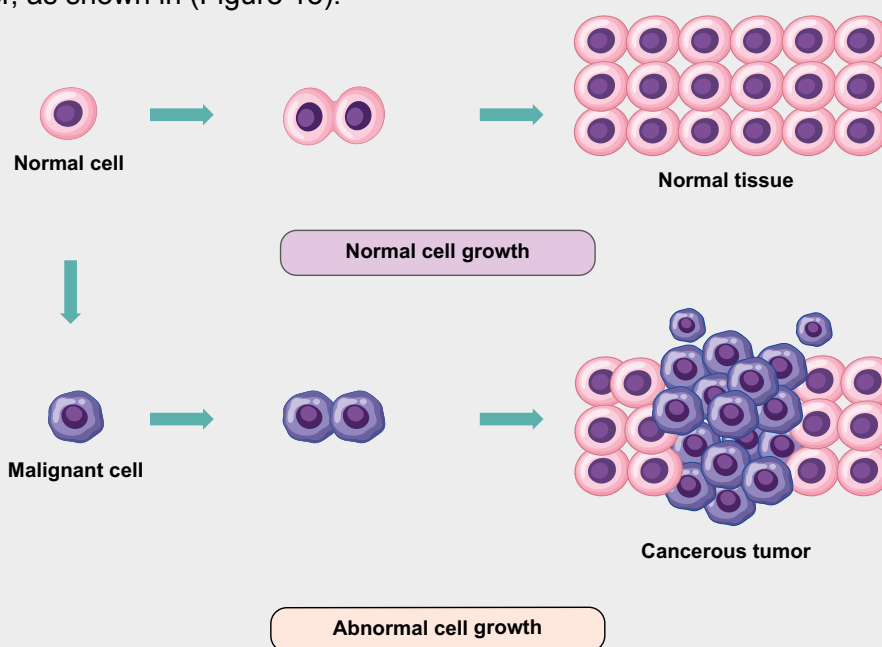


Figure (15)

Normal and abnormal mitotic division

Mathematical Understanding

- The total number of cells (N) formed after a given number of mitotic divisions (n) can be calculated using the formula: $N = 2^n$



Check Your Understanding

Calculate the number of cells produced when one somatic cell undergoes three successive mitotic divisions.

- Why is meiosis described as a **reduction** division?
- How are gametes formed inside the gonads?

Activity 3 Observe and conclude

Figure (16) shows a type of cell division occurring in one of the gonadal cells..

- 1 What is the number of daughter cells formed at the end of this division?
.....
- 2 How many chromosomes are present in each of the resulting cells?
.....
- 3 What is the difference in chromosome number between cell (1) and cell (2)?
.....
- 4 Do you expect a difference in genetic information between cell (1) and cell (2)? Why?
.....

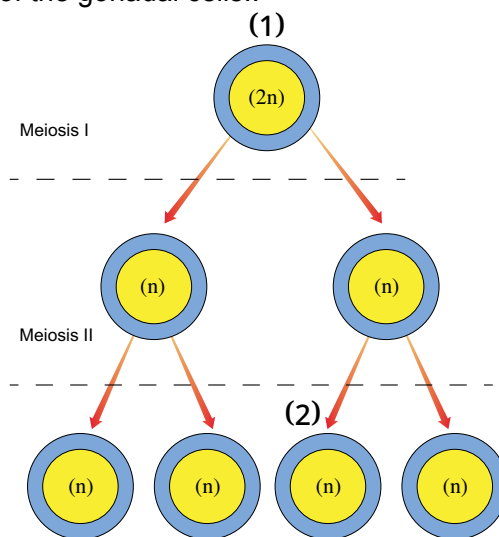


Figure (16)

- **Meiosis** is the type of cell division in which one parent cell divides to produce four daughter cells, each containing half the number of chromosomes (n) compared with the original cell ($2n$). For this reason, **meiosis** is known as **reductional division**.
Meiosis occurs through two successive stages:
Meiosis I, during which the chromosome number is reduced by half, producing two cells each with (n) chromosomes.
Meiosis II, which resembles mitosis, resulting in four cells, each still containing (n) chromosomes. These cells later develop into sperm cells, ova, pollen grains or ovules.
- A key feature of meiosis is the production of genetically different cells. This variation arises due to the occurrence of crossing-over phenomenon between homologous chromosomes during Meiosis I (Figure 17), which increases genetic diversity among individuals of the same species.

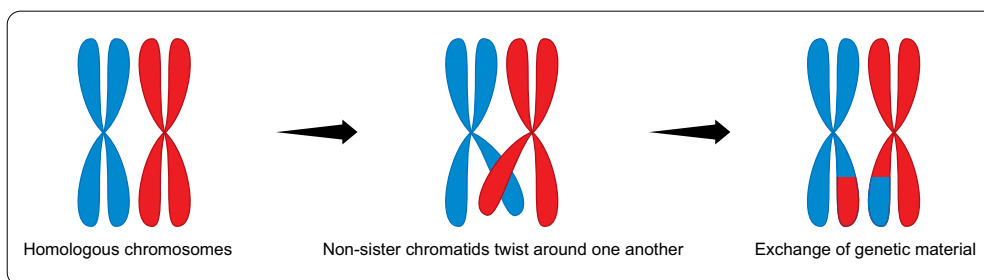


Figure (17)

Crossing-over phenomenon

Meiosis occurs in humans to serve two main purposes :

- (1) Formation of gametes (sperms and ova) inside the gonads.
- (2) Reduction of the chromosome number to half in the gametes, which ensures that the original chromosome number of the species is restored after fertilization and remains constant across successive generations.



Check Your Understanding

Does meiosis occur in unicellular organisms such as Amoeba? Explain your answer.

Sexual reproduction

- **Sexual reproduction** is a type of reproduction that involves two parent individuals of the same species, one male and one female.
- It occurs through the fusion of the male gamete nucleus (n) with the female gamete nucleus (n) during the process of **fertilization**, forming a **zygote** that contains the complete set of chromosomes ($2n$).

The zygote then undergoes mitotic divisions to develop into an embryo that carries a combination of traits inherited from both parents. (Figure 18)

As a result, sexual reproduction leads to genetic **variation** among individuals of the same species. (Figure 19)

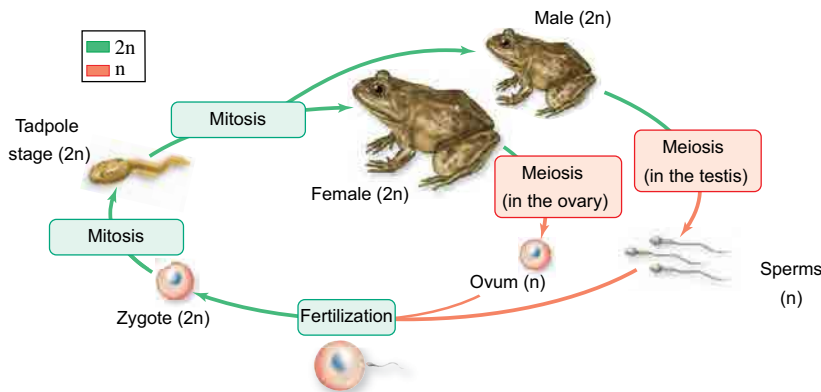


Figure (18)

Fertilization and division of the zygote



Figure (19)

Genetic diversity



Cross-Cutting Concepts : Structure and Function

The distinctive feature of each of the two types of cell division enables it to perform a specific function; mitosis achieves asexual reproduction and growth, whereas meiosis leads to the production of gametes necessary for the occurrence of sexual reproduction.



Issue for Discussion

Importance of respecting diversity among individuals within the human species.

Assessment of Lesson One

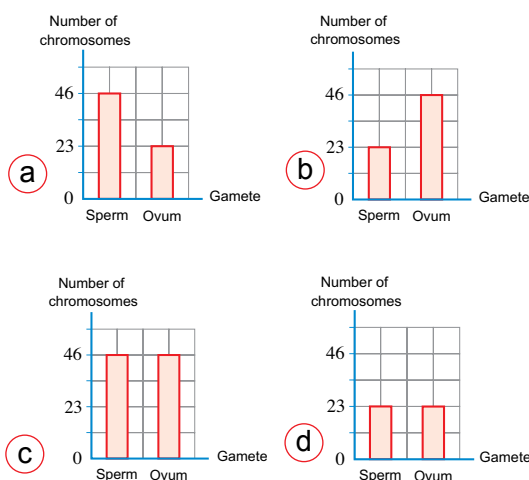


1 Mark (✓) or (X), with correction :

- (1) Gametes contain a diploid number of chromosomes ($2n$). ()
- (2) Asexual reproduction takes place by mitosis. ()
- (3) Cancerous tumors result from repeated abnormal meiotic divisions. ()
- (4) Crossing-over phenomenon between chromosomes contributes to genetic diversity among individuals. ()

2 Choose the correct answer for questions (1) - (3).

- (1) Which of the following represents the number of chromosomes found in human gametes?



- (2) The cells of parts illustrated in the opposite figure contain the same number of

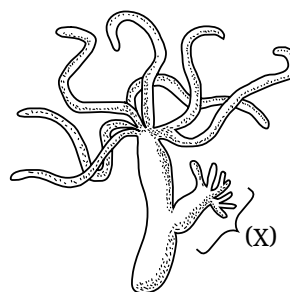
- (a) ATP molecules.
- (b) Gametes.
- (c) Chromosomes ($2n$).
- (d) Chromosomes (n).



- (3) What occurs immediately after fertilization in sexual reproduction?

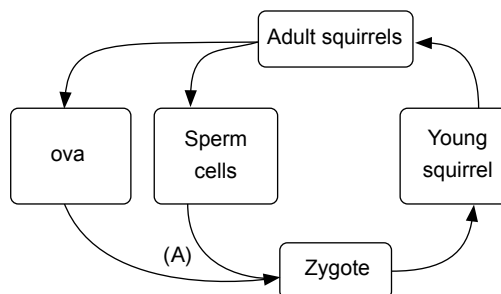
- (a) A zygote with a tetraploid chromosome number ($4n$) is formed.
- (b) The zygote begins to divide mitotically.
- (c) The zygote undergoes meiotic division.
- (d) A zygote with a haploid chromosome number (n) is formed.

3 The figure shows the reproduction of a living organism produced by a single parent



- (1) Is the number of chromosomes in the cells of part (X) resulting from the reproduction process equal to (n) or ($2n$)?
- (2) What is the type of this reproduction?
- (3) Does this reproduction occur via Meiosis or Mitosis?

4 The diagram shows the reproduction cycle of the squirrel in which the zygote contains 40 chromosomes:



- (1) What is the name of process (A)?
- (2) What is the number of chromosomes in each cell of:
1- Young squirrel. 2- The ova.

Lesson Two

Floral Reproduction



Lesson Terminology :

- Typical Flower
- Inflorescence
- Sepal
- Petal
- Perianth
- Stamen
- Carpel
- Cross Pollination
- Self Pollination
- Wind Pollination
- Insect Pollination
- Fertilization
- Fruits
- Seeds
- Ovary



Included Skills, Values and Issues :

- **Skills** : Cognitive.
- **Values** : Cooperation.
- **Issues** : The role of flowers in improving mental health.



Cross-Cutting Concepts :

Structure and Function.



Lesson Objectives :

By the end of the lesson, students will be able to:

- 1 Identify the life cycle of flowering plants.
- 2 Identify the structure of a typical flower.
- 3 Explain the functions of the floral whorls.
- 4 Distinguish between the processes of pollination and fertilization in flowers.
- 5 Differentiate between self-pollination and cross-pollination.
- 6 Identify the different means of pollen grain transfer.
- 7 Compare the characteristics of wind-pollinated flowers with those pollinated by insects.



Lesson Introduction :

The figure shows a flower. This lesson explores the ideas that help you answer these questions:

- What are the green and red leaves? And what is their importance to the flower?
- Does the flower contain structures other than these leaves?
- What is meant by floral reproduction and pollination? And what are its methods?
- How does Sexual reproduction take place in the flower?



- Flowering plants are one of the most widespread plants in different environments around the world. They are also the most important plants to humans since humans depend on them as food. Flowering plants ensure the continuity of their species through sexual reproduction, which takes place in the flowers.

Origin of Flowers

- **The flower** develops from a vegetative bud that undergoes modification to perform a reproductive function. It usually arises from the axil of a leaf known **as a bract** (Figure 1). In some plants, a part of the stem bears a cluster (group) of flowers called an **inflorescence**, and the stem part that carries it is known as the peduncle. Inflorescences vary in shape, including the following types:

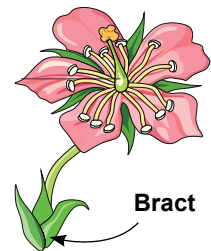


Figure (1)

(1) Simple raceme:

Some inflorescences have a long main peduncle that continues to grow, bearing flowers on all sides. Each flower is carried on a small stalk, giving the inflorescence a shape similar to a cluster of grapes (Figure 2). The flowers open sequentially from the bottom, where the older flowers are found, toward the top, where the younger flowers develop. Examples include snapdragon and stock flowers.

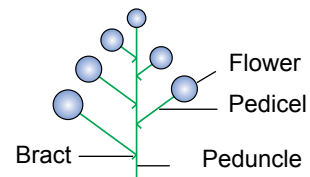


Figure (2)
Simple raceme

(2) Simple corymb:

Other inflorescences possess a short main peduncle that stops growing after producing a number of flowers, which arise only from the sides of the axis. This gives the inflorescence a comb-like shape (Figure 3). The flowers open from the outside (oldest) to the center (youngest). All flowers are found at nearly the same level. Examples include cherry and Iberis (candytuft).

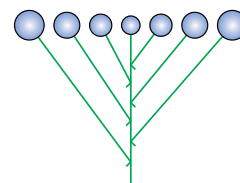


Figure (3)
Simple corymb

(3) Simple umbel:

In another type of inflorescence, all flowers arise from a single point at the tip of the peduncle, forming a structure that resembles an umbrella or tent (Figure 4). The older flowers are on the outside and the youngest flowers are in the center, and their pedicels are equal in length. Examples include garlic and onion.

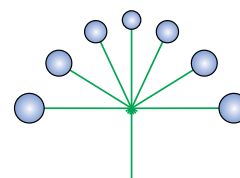


Figure (4)
Simple umbel

Flower Structure

- The **flower** is the organ of sexual reproduction in flowering plants. It represents a short stem whose leaves are modified to perform the reproductive function.

Activity 1 Observe and Explore

Figures (5)–(7) illustrate the floral whorls of three different flowers.

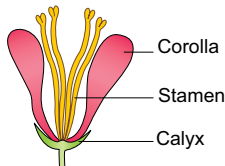


Figure (5)

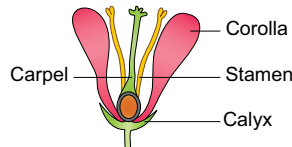


Figure (6)

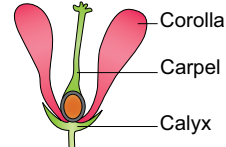


Figure (7)

① **What** are the two common floral whorls existing in the three flowers?

.....

② **Which floral whorl is present in:**

- The flower shown in Figure (6) but absent in the flower shown in Figure (5)?

.....

- The flower shown in Figure (6) but absent in the flower shown in Figure (7)?

.....

③ **Which floral whorls** are present in the flower shown in Figure (6), arranged from outside to inside ?

.....

- The flower consists of a slender stalk, called the pedicel, which ends in a swollen part known as the receptacle. The receptacle bears the floral leaves, which are arranged in groups called floral whorls.
- A flower that contains four distinct floral whorls (calyx, corolla, stamens, and pistil) is known as a **typical flower** (Figure 8).

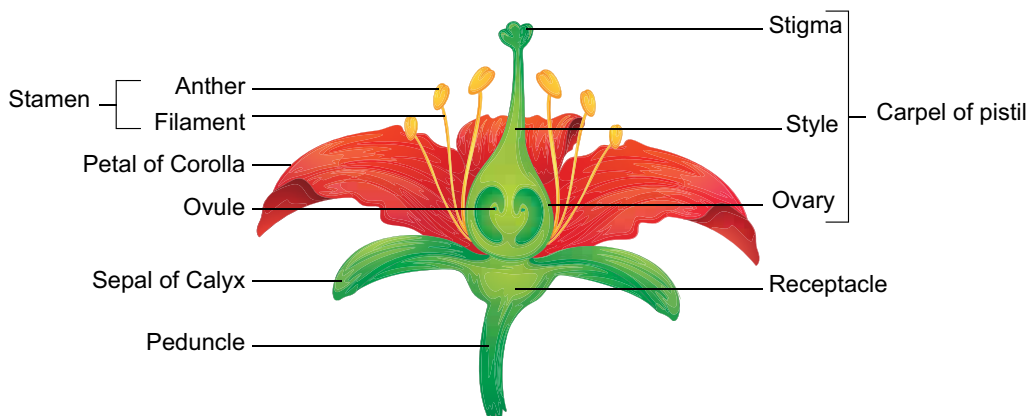


Figure (8)

Longitudinal section of a typical flower

Arrangement of floral whorls from outside to inside:

① Calyx:

The calyx is composed of **green leaves** called **sepals**, whose number varies from one type of flowers to another. Sepals may be **separate (not attached to each other)**, as in the rose flower (Figure 9), or **fused**, as in the petunia flower (Figure 10). The primary **function** of the **calyx** is to protect the inner parts of the flower, especially before blooming.



Figure (9)
Free sepals of Rose



Figure (10)
Fused sepals of Petunia

② Corolla:

The corolla lies internal to the calyx and consists of delicate **white or colored** leaves called **petals**. Petals are often fragrant, helping to attract insects that assist in the process of floral reproduction. The number of petals usually equals the number of sepals and alternates with them in position. Petals may be fused and arranged in a single whorl, as in the petunia flower (Figure 11), or separate and arranged in several whorls, as in the Egyptian rose flower (Figure 12).

The corolla functions in protecting the reproductive organs of the flower and in attracting pollinating insects that play a vital role in completing sexual reproduction.



Figure (11)
Petunia petals
fused and arranged in one whorl



Figure (12)
Egyptian rose petals
separate and arranged in several whorls

In some flowers, such as the daffodil (Figure 13), sepals cannot be distinguished from petals based on color or appearance. In these flowers, the calyx and corolla are collectively referred to as the **perianth**.

In contrast, some flowers lack both sepals and petals and are therefore known as naked flowers, such as willow flowers (Figure 14).



Figure (13)
Daffodil flower



Figure (14)
Willow flowers



Integration with Medical Science

Flowers have many medical benefits because they contain antioxidants and volatile oils.

Examples include:

- Chamomile flowers (Figure 15), which are used to calm the nervous system.
- Hibiscus flowers (Figure 16), which help lower high blood pressure.
- Lavender flowers (Figure 17), which are used to relieve muscle pain and headache.



Chamomile flowers
Figure (15)



Hibiscus flowers
Figure (16)



Lavender flowers
Figure (17)

Entrepreneurship

- Some villages in Fayoum Governorate are well known for cultivating roses, whose petals are used in the production of rose water and rose oil. Work with your classmates to propose ideas for developing these industries and promoting them in global markets.

3 Stamens:

The **male** organ of the flower lies just inside the corolla and consists of several modified leaves called **stamens** (Figure 18). Each stamen is made up of a thin **filament** that ends in a swollen structure known as the **anther**. The anther typically consists of two lobes, each containing two pollen sacs filled with tiny grains called **pollen grains**.

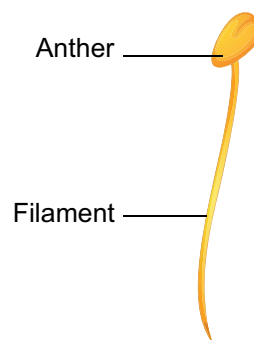


Figure (18)
Stamen

4 Pistil:

The **female** organ is located at the center of the flower and consists of one or more leaves called carpels, collectively forming the **pistil** (Figure 19), which resembles a flask in shape. Each carpel includes a swollen base called **the ovary**, connected to a slender tube known as the style, which ends in a sticky surface called **the stigma**.

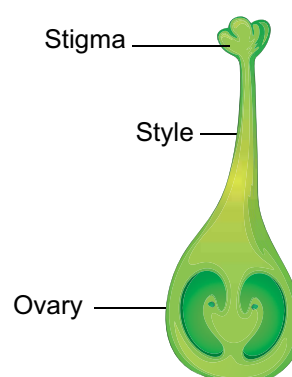


Figure (19)
Carpel

The sex of the Flower

A typical flower is described as **bisexual** because it contains **both male and female** reproductive organs. Such flowers are known as bisexual flowers and are symbolized by (♀), as seen in tomato and eggplant flowers.

Some flowers contain only the gynoecium without the stamens and are therefore classified as **female** flowers, symbolized by (♀). Others contain only the stamens without the pistil and are classified as **male flowers**, symbolized by (♂). Male and female flowers are known as **unisexual** flowers. Examples include palm, maize (corn), and Pumpkin flowers.

Protective Awareness

- **Hay fever** is a kind of inflammation caused by an immune response to harmless substances such as pollen grains. Its symptoms include frequent sneezing and watery eyes. The condition can be reduced by avoiding areas where pollen concentrations are high.

Information and Communication Technology



Accurate information about regions having elevated pollen grain levels can be obtained through specialized applications such as Pollen.com.

Pollination and Fertilization in Flowers

First

Pollination

Reproduction by seeds is one of the most important factors that has contributed to the wide spread of flowering plants. The transfer of pollen grains from the anthers of the stamens to the stigmas of the carpels (pistils) is known as **pollination**.

Activity 2 Observe and Conclude

Figures (20) and (21) illustrate the two main types of pollination that occur in flowering plants of the same species.

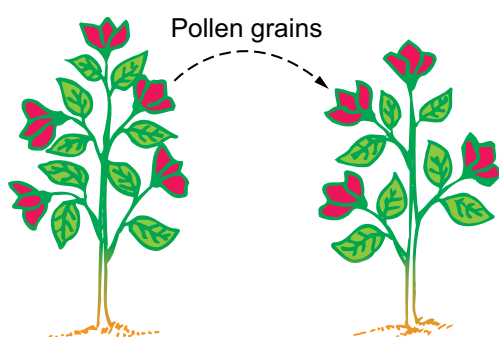


Figure (20)

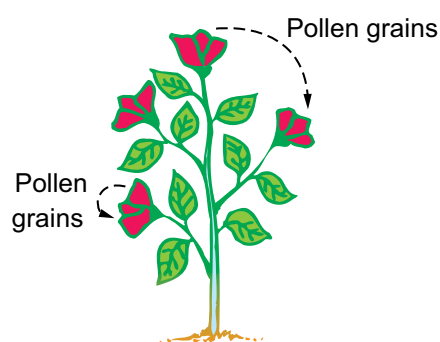


Figure (21)

How does the pollination process shown in each figure take place?

① Figure (20)

.....

② Figure (21)

.....

There are two types of pollination:

- ① **Cross-pollination** occurs when pollen grains are transferred from the anther of a flower on one plant to the stigma of a flower on another individual of the same species (Figure 20). Flowers that undergo cross-pollination are characterized by the following features:
 - (1) Stamens and pistils do not mature at the same time.
 - (2) Anthers are positioned far from stigmas or at a lower level.
 - (3) The flowers are unisexual.
- ② **Self-pollination** occurs when pollen grains are transferred from the anther to the stigma of the same flower or to the stigma of another flower on the same plant (Figure 21). Flowers that undergo self-pollination are characterized by:
 - (1) Simultaneous maturity of the stamens and the pistil.
 - (2) Anthers are at the same level as, or slightly higher than, stigmas.
 - (3) In some cases, the flower remains closed and does not open until pollination is completed.

Methods of Pollination

Flowering plants depend on several methods to transfer pollen grains, including wind, insects, water, and humans.

Characteristics of wind-pollinated flowers:

- ① Their petals are small and dull-colored.
- ② They are usually scentless and do not produce nectar.
- ③ Their anthers are long and hang outside the flower, making them easy to shake by the wind (Figure 22).
- ④ Their pollen grains are light, dry, and smooth, and are produced in large quantities to compensate for losses in the air.
- ⑤ Their stigmas are feathery, sticky, and often exposed outside the flower to trap pollen grains.



Figure (22)

Anthers are long and hang outside

Characteristics of insect-pollinated flowers:

- ① Their petals are large with bright colors (Figure 23).
- ② They have a noticeable scent and secrete nectar to attract insects.
- ③ Their anthers are located inside the flower due to short filaments.
- ④ Pollen grains are sticky or rough, allowing them to adhere to the bodies of visiting insects.
- ⑤ Stigmas are sticky and located inside the flower to pick up pollen stuck to insects' bodies.



Figure (23)

Large bright petals



Cross-Cutting Concepts: Structure and Function

Light, smooth pollen grains are usually transported by wind, whereas sticky or rough pollen grains are commonly transferred by insects.

Second Fertilization

- When a pollen grain falls on the stigma of a flower of the same species, the stigma secretes a sugary solution that the pollen grain absorbs. This causes the pollen grain to germinate and form a structure known as the **pollen tube**.
- The generative nucleus of the pollen grain divides mitotically to produce two male nuclei (n).
- The pollen tube grows down through the style and reaches the ovule through the micropyle (Figure 24).
- The tip of the pollen tube then breaks down, allowing fertilization to occur when one male nucleus fuses with the ovule nucleus to form a fertilized ovule (zygote) with a diploid chromosome number (2n).
- The zygote divides mitotically to form an **embryo**, which develops into a seed that can germinate to produce a new plant.

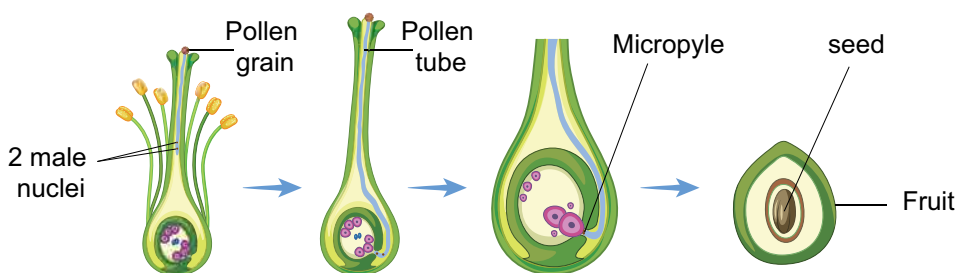


Figure (24)

Fertilization process and fruit formation

- After fertilization, the ovary enlarges and develops into a fruit, while the ovules inside the ovary become seeds (Figure 24). After fruit formation, the calyx, corolla, androecium, style, and stigma usually wither and fall off.
- In some plants, certain floral parts may remain attached: the calyx persists in tomato and eggplant (Figure 25), the corolla remains in cucumber and zucchini (Figure 26), and both stamens and sepals persist in pomegranate (Figure 27).



Figure (25)

Calyx in Egg plant



Figure (26)

Corolla in Zucchini



Figure (27)

Stamens and sepals
in Pomegranate



Scientific Skills: Deduction

Why does the peach fruit contain a single seed, while a pea pod contains many seeds?



Issue for Discussion

Flowers role in improving mental health.

Life Cycle of Flowering Plants

The life cycle of flowering plants passes through four main stages, as shown in Figure (28):

- ① **Germination:** During this stage, the seed develops into a seedling that begins to emerge from the soil.
- ② **Vegetative growth:** The plant forms its roots, stem, and leaves.
- ③ **Reproduction:** The mature plant produces flowers, which then form fruits containing seeds.
- ④ **Seed dispersal:** Seeds spread by various methods to reach new locations, where a new life cycle begins.

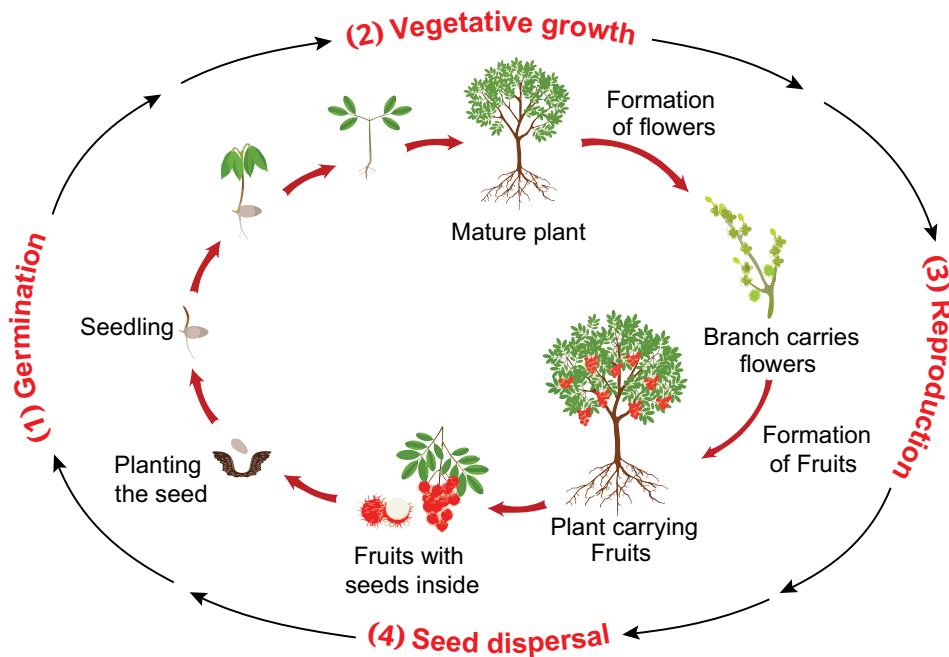


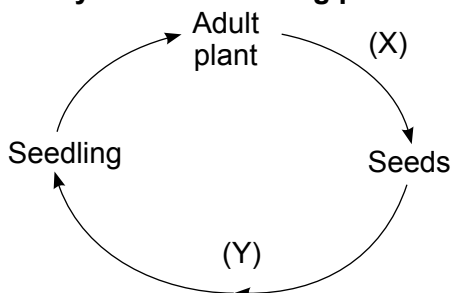
Figure (28)
Life cycle of flowering plants

Assessment of Lesson Two



1 Choose the correct answer for questions (1) - (4).

(1) The following figure illustrates the life cycle of a flowering plant:



Which of the following describes of both processes (X) and (Y)?

- (a) (X): Germination and Fertilization, (Y): Pollination.
- (b) (X): Pollination and Fertilization, (Y): Germination.
- (c) (X): Pollination, (Y): Fertilization and Germination.
- (d) (X): Fertilization, (Y): Pollination and Germination.

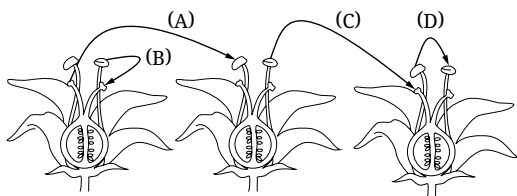
(2) The figure illustrates the structure of a flower:

Which of the following describes this flower?



- (a) Bisexual insect-pollinated.
- (b) Unisexual wind-pollinated.
- (c) Unisexual insect-pollinated.
- (d) Bisexual wind-pollinated.

(3) In the following figure:



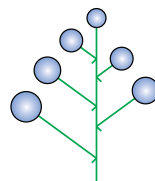
Which letter indicates cross – pollination?

- (a) (A).
- (b) (B).
- (c) (C).
- (d) (D).

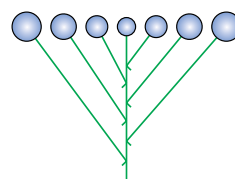
(4) Which statement correctly describes the petunia flower?

- (a) Its petals are arranged in a single whorl.
- (b) Its petals are green in color.
- (c) Its sepals are separate.
- (d) The number of its sepals is double the number of its petals.

2 In front of you are two examples of Inflorescences you have studied:



(Figure 1)

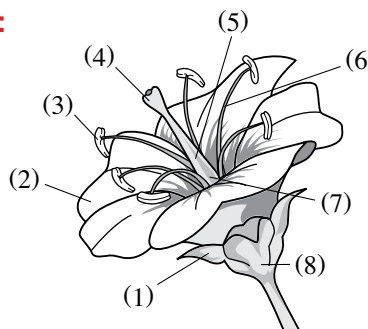


(Figure 2)

Compare between them in terms of:

- (1) Type of Inflorescence.
- (2) Length of the peduncle.
- (3) Reason for naming.

3 Replace the numbers shown in the following figure with the appropriate labels:



4 Compare each pair. (Two points are required for each):

- (1) Self-pollination and cross-pollination.
- (2) Wind pollination and insect pollination.

5 What is the structure of:

- (1) The male organ in the flower?
- (2) The female organ in the flower?

UNIT 4

Physical Changes in the Atmosphere

Unit Lessons

Lesson one : Effect of Temperature and Pressure on Climate

Lesson two : Winds and Weather Forecasts

Learning Outcomes :

By the end of this unit, students will be able to:

1. Explain the difference between local weather and climate elements.
2. Prove that the wind is caused by the motion of air from areas of high pressure to areas of low pressure.
3. Analyze data from weather maps to describe weather changes.
4. Write a report on local weather patterns that caused by the motion of water in the atmosphere.
5. Explain the circulation of the atmosphere due to solar radiation and the Coriolis effect.
6. Conclude that weather forecasts are probabilistic.

Lesson One

Effect of Temperature and Pressure on Climate



Lesson Terminology :

- Climate.
- Weather.
- Atmospheric Pressure.
- Wind.
- Latitude.
- Equator.
- North Pole.
- South Pole.
- Daily Average Temperature.
- Daily Temperature Range.
- Absolute Humidity
- Relative Humidity



Included Skills, Values and Issues :

- **Skills** : Practical - Mathematical.
- **Values** : Collaboration
- **Issues** : Climate Change and Sustainable Development.



Cross-Cutting Concepts :

- Cause and Effect.



Lesson Objectives :

By the end of the lesson, students will be able to:

- 1 Differentiate between weather and climate.
- 2 Identify the elements of weather and climate.
- 3 Conclude the factors affecting air temperature.
- 4 Conclude the factors affecting atmospheric pressure.
- 5 Analyze a given set of data to explore the relationship between atmospheric pressure and elevation above sea level.



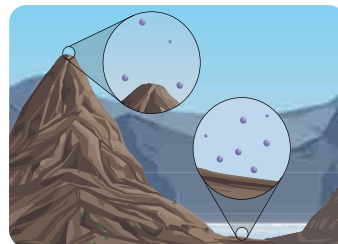
Lesson Introduction :

The figure illustrates air particles at the summit and base of a mountain.

This lesson explores ideas that will help you answer the questions below :

What is the relationship between atmospheric pressure and elevation above sea level?

Why does the weather in one location differ from the weather in another location at the same time?



When listening to weather reports, you might hear something like this:

"Hot and humid weather over Cairo and the Nile Delta, very hot and humid over South Sinai and the south of the country during the day, and warm and humid at night over most areas". It is generally known that the climate of the coastal countries on the Mediterranean Sea is hot and dry in summer and mild and rainy in winter.

So, what is the difference between weather and climate?

Weather is the overall instantaneous condition of the atmosphere at certain place and time, while climate is the atmospheric condition in that same place over a long period of time. The elements of weather and climate are the same.

Elements of Weather and Climate

- The key elements of weather and climate include temperature, solar radiation, atmospheric pressure, wind, humidity, condensation, and precipitation.

This study will focus on the following elements:

- **Temperature**
- **Atmospheric pressure**
- **Wind**

Temperature

Temperature is considered the most important climatic element due to its direct impact on human life and on the distribution of plants and animals on the surface of the Earth (Figures 1 & 2).



Figure (1)

Egyptian lynx (Caracal) is one of the animals of the hot region



Figure (2)

The polar bear is one of the animals of the northern polar region

Factors affecting temperature

The most important factors that can cause differences in air temperature from one zone to another are:

1 Difference in latitude

Temperature is high near the Equator because the Sun's rays are almost perpendicular to these regions. It decreases as we move away from the Equator toward the poles. This is because the angles by which Sun's rays falling on these zones become more inclined. As a result, the same amount of the solar energy is spread over a larger area. Therefore, the distribution of thermal zones on Earth differs according to latitude (Figure 3).

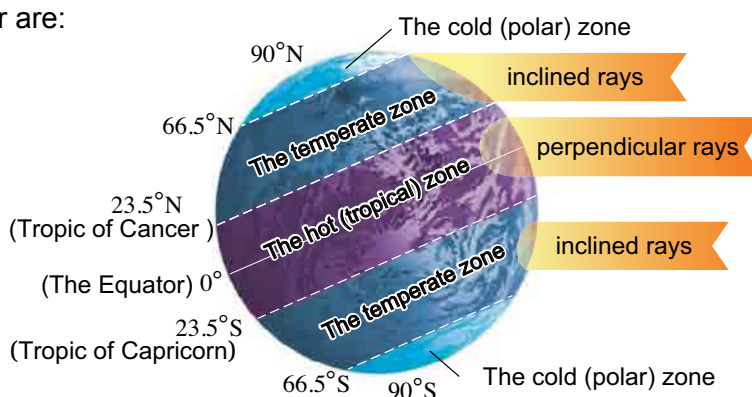


Figure (3)

Difference of thermal zones according to latitude



Cross-Cutting concept : Cause and Effect

The farther we move away from the Equator to north or south (**cause**) the temperature decreases (**effect**).



Check your understanding

Egypt lies between latitudes 22°N and 32°N. Complete the blanks in Table (1) with the suitable data:

Table (1)

The City	Latitude	Thermal zone
Alexandria	31°N	.....
Cairo	30°N	.....
Aswan	24°N	.....

2 Proximity to water bodies

The high specific heat of water compared to land makes water bodies cooler than the adjacent land during the day, which causes a sea breeze (Figure 4). At night, water remains warmer than the land, which causes a land breeze (Figure 5). In general the air temperature is affected by the temperature of the water or land beneath it.

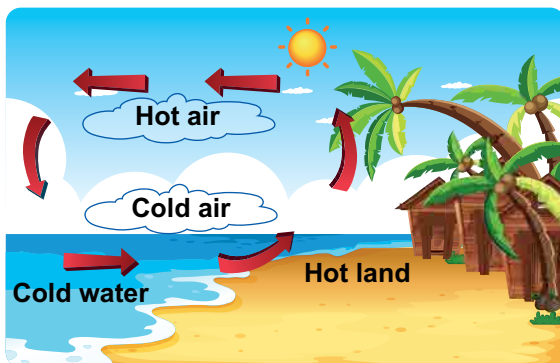


Figure (4)
Sea breeze

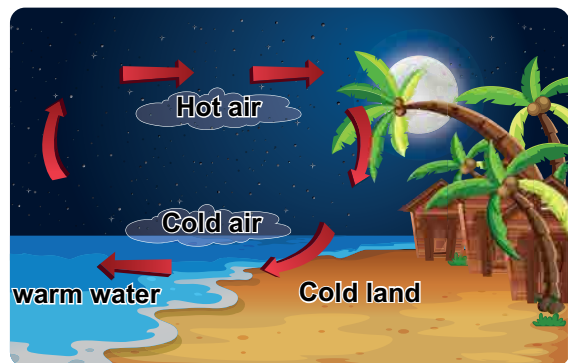


Figure (5)
Land breeze

3 Altitude (height above sea level)

As we go higher above sea level (altitude increases), temperature decreases for several reasons. One main reason is the expansion of air and the decrease in its density (Figure 6). This causes air particles to move farther apart and slow down. Air temperature decreases.

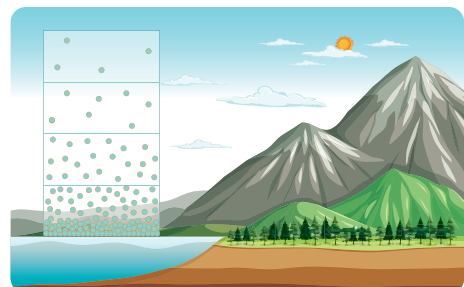


Figure (6)
Air density decreases
as altitude increases

The highest temperature recorded during the day is known as the **maximum temperature**, while the lowest is called the **minimum temperature** (Figure 7). The mean of these two values is referred to as the **daily average temperature**, and the difference between them is called the **daily temperature range**.



Check your understanding

The maximum temperature on one day was 38°C and the minimum temperature was 23°C in Northern Upper Egypt.

Calculate:

(1) Daily average temperature.

• Daily average temperature = $\frac{\text{.....} + \text{.....}}{2} = \text{.....}$

(2) Daily temperature range.

• Daily temperature range = $\text{.....} - \text{.....} = \text{.....}$

The effect of temperature appears clearly on **atmospheric pressure** and **wind**.



Figure (7)

Maximum and Minimum Temperatures



Research Activity

Search various sources of information, such as the Internet or artificial intelligence applications, to learn about mountain and valley breezes.

Atmospheric pressure

• Does air have weight? Does it have pressure?



Activity 1 Practical work

Materials and Tools:

- Two identical inflated balloons of the same volume.
- A rod.
- A pin.

Steps:

- 1 Fix the rod in a horizontal position.
- 2 Hang the two balloons on the rod to form a balanced first-class lever (Figure 8).

What do you observe when one of the balloons is pierced with the sharp pin?

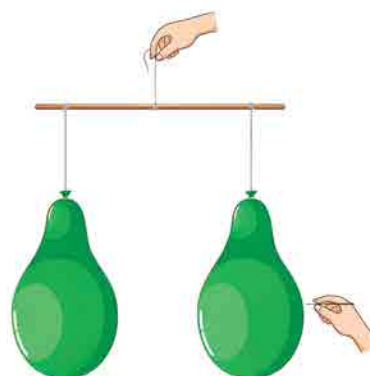


Figure (8)

Activity 2 Practical work

Materials and Tools :

- Peeled boiled egg.
- A piece of paper.
- A bottle.
- A matchstick.

Steps :

- 1 Ignite the piece of paper, then put it in the bottle.
- 2 Immediately place the peeled, boiled egg on the mouth of the bottle to close it (Figure 9).

Does the egg slide into the bottle while the piece of paper is burning or after the flame goes out?

.....

Based on Activities (1) and (2), it is concluded that:

- Atmospheric air has weight. This is demonstrated by the tipping of the balanced lever when one of the two balloons is pierced.
- Atmospheric air has pressure, which is demonstrated by the egg being pushed into the bottle. As the paper inside the bottle burns, the air temperature increases in the closed space, causing the pressure to rise since the air volume remains constant. Once the flame goes out, the air inside cools rapidly, resulting in a lower pressure inside the bottle compared to the atmospheric pressure outside. This pressure difference pushes the egg into the bottle.
- Atmospheric pressure is defined as the weight of a column of air with a cross-sectional area of 1 m^2 and a height extending to the top of the atmosphere. It is measured using a mercury barometer (Figure 10).
- Atmospheric pressure at sea level is called **Normal Atmospheric Pressure**. It is equivalent to the weight of a column of mercury 76 cm high acting on a unit area (Figure 10). This is equal to (760 mm.Hg) or 1013.25 millibars (mb).



Figure (9)

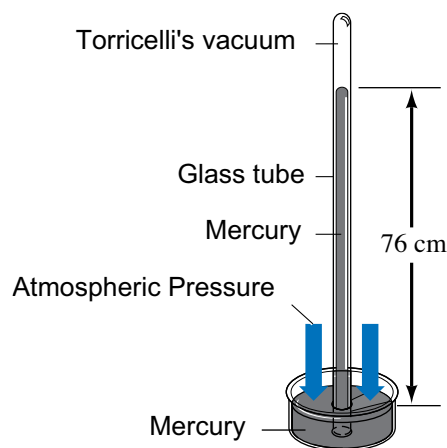


Figure (10)

Mercury barometer

Mathematical understanding

- Each 1 millibar (mb) equals 0.75 millimeters of mercury (mm.Hg).
Pressure in (mb) = Pressure in (mm Hg) $\div$ 0.75



Issue for discussion

Climate change and sustainable development.

Factors Affecting Atmospheric Pressure

There are several factors that affect atmospheric pressure, including:

1 Altitude (height above sea level)

- As we go higher above sea level (altitude increases), The height of the air column extending to the top of the atmosphere decreases, and consequently, its weight acting on the unit area also decreases. Therefore, atmospheric pressure decreases, as shown in Table (2).

Table (2)
“for clarification only”

Altitude (m)	Atmospheric pressure (mb)
1000	899.76
2000	795
3000	701
5000	540.2

2 Temperature

- When the temperature of the Earth’s surface rises, the air above it expands. This leads to a decrease in its density and, therefore, a decrease in atmospheric pressure. vice versa.

3 Humidity

- **Humidity** refers to the amount of water vapour present in the air, and its value varies from one place to another and over time.

Absolute humidity is the actual mass of water vapour contained in a certain volume of atmospheric air and is measured in (g/m^3) .

Relative humidity is the percentage of the actual amount of water vapour in the air (absolute humidity) to the maximum amount of water vapour the same volume of air can hold at the same temperature.

When humidity increases, atmospheric pressure decreases slightly because water vapour is less dense than dry air.



Integration with Biology

The spread of influenza increases during winter because cold air has low humidity. When indoor air is heated while absolute humidity remains unchanged, relative humidity decreases sharply. This leads to the rapid evaporation of respiratory droplets, allowing viruses to remain suspended in the air for longer periods. In addition, the evaporation of moisture from the mucous membranes of the nose and respiratory tract weakens their ability to trap and defend against viral infections.

Assessment of Lesson One



- 1 Choose the correct answer for questions (1) - (4).

(1) The most important climatic element is

- (a) temperature.
- (b) atmospheric pressure.
- (c) humidity.
- (d) wind.

(2) Normal atmospheric pressure equal

- (a) 1013.25 mm Hg
- (b) 760 mb.
- (c) 1013.25 mb.
- (d) 760 cm Hg

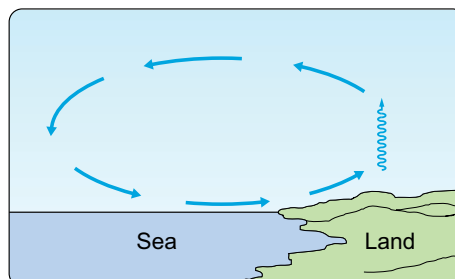
(3) Which of the following is correct?

Choice	Atmospheric Pressure	Reason
(a)	Decreases as humidity increases	The density of water vapor is less than the density of air
(b)	Decreases as humidity increases	The mass of water vapor is less than the mass of air
(c)	Increases as humidity increases	The density of water vapor is less than air
(d)	Increases as humidity increases	The mass of water vapor is less than the mass of air

(4) Which of the following is correct?

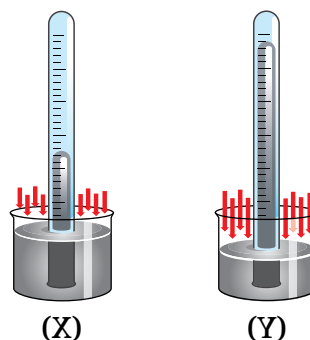
- (a) Temperatures are equal at latitude 30° North and latitude 0°.
- (b) Temperatures are equal at latitude 30° South and the Equator.
- (c) Temperature at latitude 60° North is higher than at latitude 0° in winter.
- (d) Temperature at latitude 60° North is lower than at the Equator in winter.

- 2 The following figure represents one of the natural phenomena:



- (1) What is the name of this phenomenon? Does it occur during the day or at night?
- (2) According to what you have studied, mention. What is the cause of this phenomenon?

- 3 The following figure shows a device placed at the base of a mountain once, and at its peak another time.



- (1) What is the name of this device, and what is it used for?
- (2) Identify which figure, (X) or (Y), represents the device when it is at the peak of the mountain. Explain your answer.

- 4 One cubic meter of air in a certain region becomes saturated with 20 g of water vapour at 20°C.
Calculate the relative humidity in this region if one cubic meter of its air contains 10 g of water vapour at 20°C.

- 5 Compare between land breeze and sea breeze (Two points only).

- 6 Why do thermal zones differ on the surface of the Earth?

Lesson Two

Winds and Weather Forecasts



Lesson Terminology:

- Coriolis Effect.
- Weather Map
- High-Pressure system
- Low-Pressure system
- Sunny
- Clouds
- Rain
- Snow
- Thunder and Lightning
- Hurricanes
- Weather Forecasts
- Stevenson screen
- Radiosonde



Included Skills, Values, and Issues :

- **Skills** : Practical - cognitive.
- **Values** : Collaboration.
- **Issues** : Climate changes and extreme weather.



Lesson Objectives :

By the end of the lesson, students will be able to:

- 1 Write a report on the relationship between atmospheric pressure zones and wind directions.
- 2 Identify Coriolis effect.
- 3 Differentiate between atmospheric pressure systems.
- 4 Understand weather forecasts.

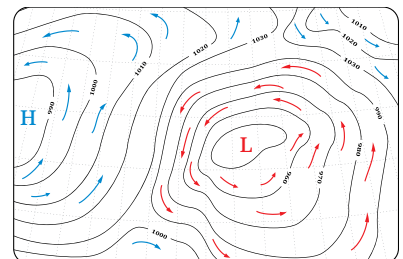


Lesson Introduction :

The figure shows a weather forecast map.

This lesson explores ideas that will help you answer the questions below:

- What does each of the letters H and L indicate?
- What do the blue and red arrows indicate?
- What is the direction of wind movement?



Wind

- Wind is defined as the horizontal movement of air across the Earth's surface, caused by difference in atmospheric pressure between regions due to unequal heating of the Earth's surface.
- The high temperature and relative humidity in equatorial regions lead to the formation of **low-pressure** region (L), while the lower temperature and relative humidity in polar regions result in **high-pressure** region (H) (Figure 1).
- Air moves from regions of high atmospheric pressure to regions of low atmospheric pressure.
- When the difference in atmospheric pressure between adjacent areas is high, wind speed and strength increase.

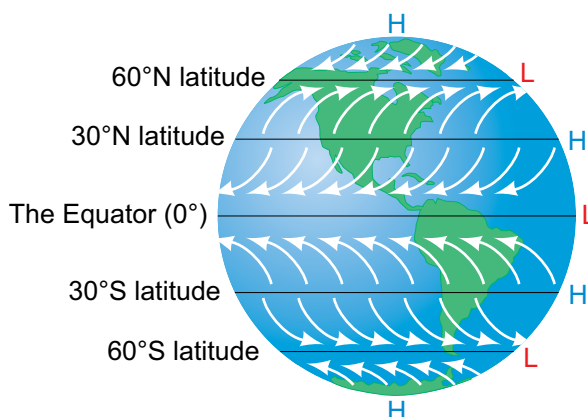


Figure (1)
Main atmospheric pressure zones

Information and Communication Technology

You can visit "Windy" application or website, which provides animated maps showing wind speed and direction, updated every five minutes.

Use this information to write a report explaining the relationship between atmospheric pressure systems and wind directions.

Coriolis Effect

Cooperate with a classmate to carry out the following activity:

Activity 1 Practical Work

Materials and Tools:

- Two inflated balloons.
- A dropper containing colored dye.

Steps:



Figure (2)

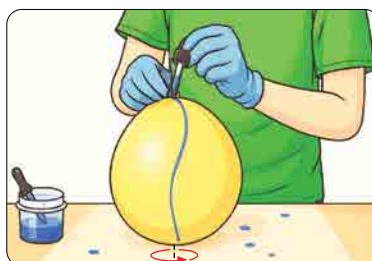


Figure (3)

- 1 Fix one of the balloons and rotate the other in the anticlockwise direction.
- 2 Use the dropper to place a drop of dye on the fixed balloon (Figure 2).
What do you observe?
- 3 Repeat the previous step with the other balloon while it is rotated (Figure 3).
What do you observe?

- Due to the Earth's rotation from west to east, winds generally do not travel in straight lines except near the Equator but instead follow curved paths. This is caused by Coriolis Effect (Figure 4), which makes moving air a drop deflect as follows:
 - In the Northern Hemisphere, wind deflects to the right of their original path, in a clockwise direction.
 - In the Southern Hemisphere, wind deflects to the left, in an anticlockwise direction
- The Coriolis Effect is strongest near the poles.

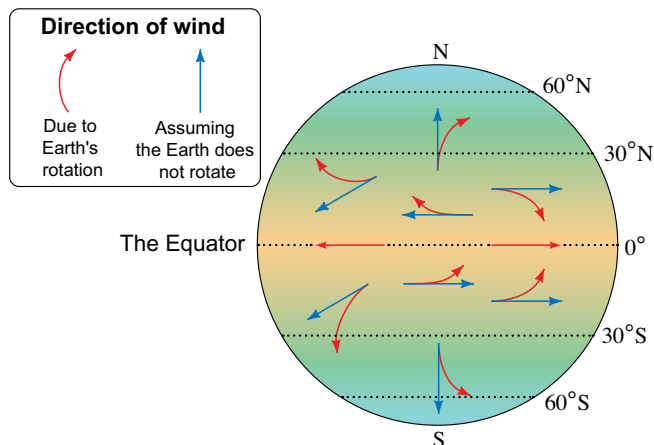


Figure (4)
Coriolis Effect

Weather Maps

Weather maps show the movement of air masses from one region to another based on wind speed and **atmospheric pressure systems**.

Atmospheric pressure systems

Atmospheric pressure systems are classified according to their values into **low-pressure systems** and **high-pressure systems**.

Activity 2 Conclude

Cooperate with a classmate to examine the weather map (Figure 5), which shows two low-pressure regions and two high-pressure region. The values shown on the curved lines indicate atmospheric pressure values measured in millibars (mb).

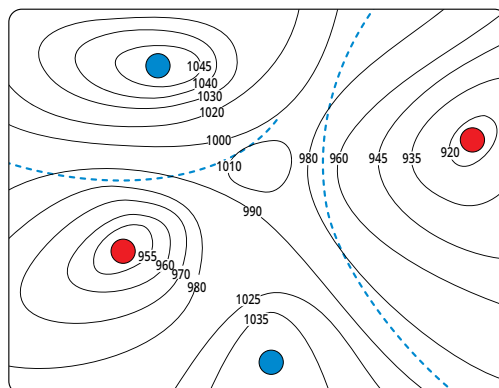


Figure (5)

- 1 Write inside two of the circles shown in Figure (5):
 - the letter L to represent a low-pressure system.
 - the letter H to represent a high-pressure system.
- 2 What happens to atmospheric pressure values as we move from the center outwards in:
 - The low-pressure region - L
 - The high-pressure region - H

- On weather maps, points of equal atmospheric pressure at sea level are connected by a curved line called **the isobar**. (a line of equal pressure)
- A **low-pressure system** is a region where the atmospheric pressure at the center is lower than that in the surrounding areas and is represented by the letter **L** in red colour (Figure 6).

These systems are associated with **rising** air currents, which cool and condense, leading to cloud formation and rainfall. In the Northern Hemisphere, air within **low-pressure systems** rotates inward **toward** the center in an anticlockwise direction.

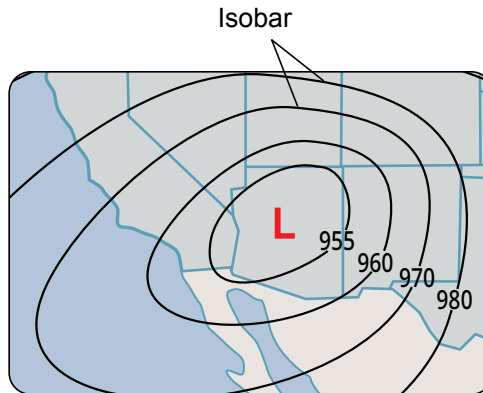


Figure (6)
Low-Pressure system

A **high-pressure system** is a region where the atmospheric pressure value at its center is higher than that surrounding areas and represented on weather maps by the letter **H** in blue colour (Figure 7).

In these regions (systems) descending air currents are formed which lead to warming and drying of the air. Therefore, the weather in these regions is clear and sunny. In the Northern Hemisphere, air within **high-pressure systems** rotates outward away from the center in a clockwise direction.

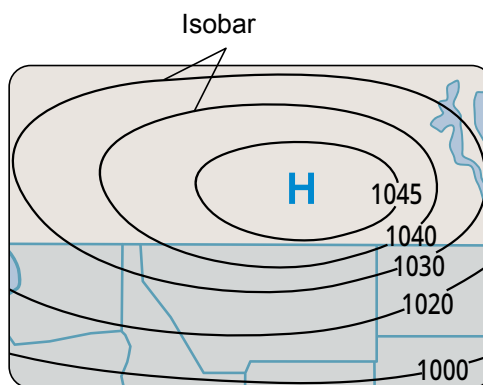


Figure (7)
High-Pressure system

Weather forecast maps include icons (symbols) that indicate weather conditions, and the expected temperature is written beside them. These include:



Figure (8)
Sunny



Figure (9)
Formation of clouds



Figure (10)
Rainfall



Figure (11)
Snowfall



Figure (12)
Thunder and lightning

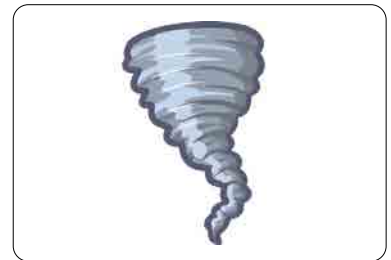


Figure (13)
Formation of Hurricanes



Research Activity

Search multiple sources of knowledge, including one artificial intelligence application, for local weather patterns that result from the movement of water vapor in the atmosphere.

Weather Forecasts

Weather forecasting is the process of predicting future weather conditions for a certain location. This is achieved by collecting, recording, and analyzing data related to temperature, wind speed, atmospheric pressure, and storm tracks using various instruments and techniques such as:

1 Stevenson screen:

Stevenson screen (weather station shelter) (Figure 14) consists of a white-painted wooden box whose length is about 65 cm, designed to reflect sunlight and allow air circulation through slanted openings. The shelter is mounted on a stand approximately 120 cm above ground level to protect instruments from heat radiated by the Earth's surface.

It is placed away from buildings and trees to avoid any obstacles that may affect the measurements. Inside the shelter, there are instruments used to measure temperature, atmospheric pressure, and humidity.



Figure (14)
Stevenson screen
(The weather station shelter)

2 Weather buoys

Weather buoys float in the oceans (Figure 15) to collect data using sensors. This data is organized, processed, then transmitted via satellites to observation centers around the world.



Figure (15)
Weather buoys

3 Radiosonde

A **radiosonde (or radio probe)** is a device that carries instruments to measure temperature, pressure, humidity, and wind speed. It is carried by a balloon filled with helium or hydrogen gas due to their low densities (Figure 16). Radiosondes are launched twice daily—at noon and midnight—from hundreds of stations worldwide. Data collected by the sensors is transmitted to ground stations via radio waves. As the balloon rises, it expands because of decreasing atmospheric pressure and eventually bursts at altitudes between 20 km and 35 km. The radiosonde then falls using a parachute and is often not reused.



Figure (16)
A balloon carrying a radiosonde

4 Satellites that orbit Earth (Figure 17).

5 Weather Stations that are distributed in different regions in all countries of the world (Figure 18).



Figure (17)
Satellite



Figure (18)
Weather station

Are weather forecasts absolute facts?

Weather forecasts are not absolute facts but probabilistic predictions, as atmospheric conditions are influenced by many interacting variables. Forecast accuracy decreases as the prediction period increases; therefore, forecasts for the next two days are generally more reliable than those for the following week.

Importance of weather forecasts

There are many fields that benefit from weather forecasts, including:

- ① **Protection of lives and property**, where appropriate preventive measures are taken when there is a probability of heat or cold waves, floods, or thunderstorms (Figure 19).



Figure (19)
Thunderstorm

- ② **Supporting economic activities** such as helping farmers determine times of planting, irrigation, harvesting, and pest control. This increases agricultural productivity and reduces losses
- ③ **Aviation safety** to avoid weather conditions that may threaten air navigation traffic.

Preventive Awareness :

- Following weather reports is essential to take appropriate precautions during periods of weather instability, such as choosing suitable clothing, avoiding crowded places, and making informed decisions about travel by land or sea. In spring, Egypt often experiences weather disturbances known as **Khamaseen** winds, which carry sand and dust and can negatively affect the health of the respiratory system.



An issue for discussion

Climate Change and Extreme Weather.

Assessment of Lesson Two



1 Choose the correct answer for questions (1) – (4).

(1) Which of the following expresses Coriolis Effect?

- (a) Its effect reaches its maximum at the Equator.
- (b) It causes winds to be deflected to the left in the Southern Hemisphere.
- (c) It does not cause wind deflection in the Northern Hemisphere.
- (d) Its effect becomes clear when atmospheric pressure values differ.

(2) Air currents in a low-pressure system rotate

- (a) In a clockwise direction, outward away from the center of the system.
- (b) In a clockwise direction, inward toward the center of the system.
- (c) In an anticlockwise direction, outward away from the center of the system.
- (d) In an anticlockwise direction, inward toward the center of the system.

(3) Lines of equal atmospheric pressure on weather maps are known as

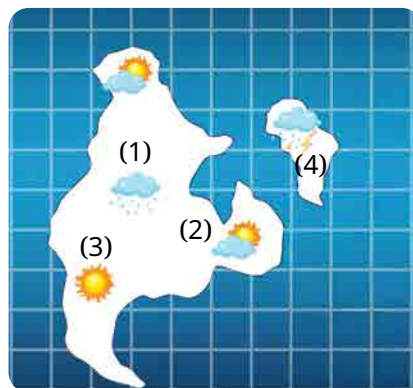
- (a) Isotopes.
- (b) Isobars.
- (c) Isotones.
- (d) Isomers.

(4) Radiosonde sensors collect weather data while they are in

- (a) The atmosphere.
- (b) The oceans.
- (c) Weather station shelters.
- (d) Weather stations.

2 Explain the relationship between atmospheric pressure, temperature, and humidity in polar regions.

3 What does each of the numbers shown on the following map indicate?



4 Mention three modern techniques used in collecting weather forecast data. (According to what you have studied)

5 Why are weather forecasts considered probabilistic predictions and not absolute facts?

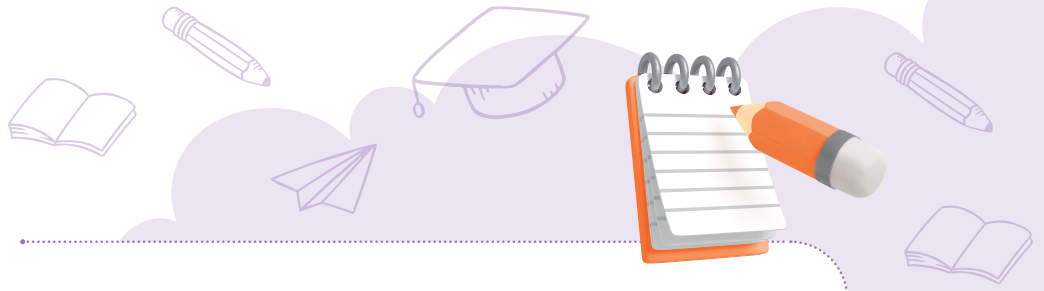
6 Mention two fields that benefit from weather forecasts.

7 What are the characteristics of Khamaseen winds?

8 Explain the following:

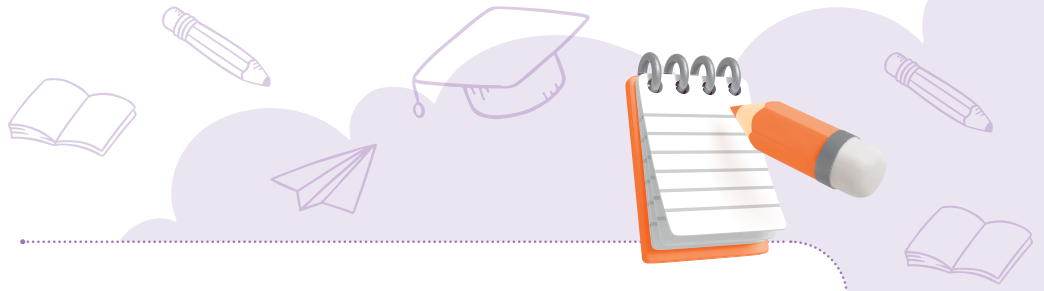
- (1) The movement of winds in straight paths at the Equator.
- (2) The air currents formed in areas of different pressure systems are not alike.
- (3) The wooden walls of the weather station shelter are painted white.

Notes



A series of horizontal dotted lines for writing notes, with a vertical dotted line on the right side and small circular markers at the end of each line.

Notes



A series of horizontal dotted lines for writing notes, with a vertical dotted line on the right side and small circular markers at the intersections.

Discover and Learn

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Second Preparatory - Second term

2025 - 2026

المقاس	وزن المتن	ألوان المتن	وزن الغلاف	ألوان الغلاف
27 x 19 سم	70 جم ورق أبيض	4 لون	180 جم كوشيه	4 لون