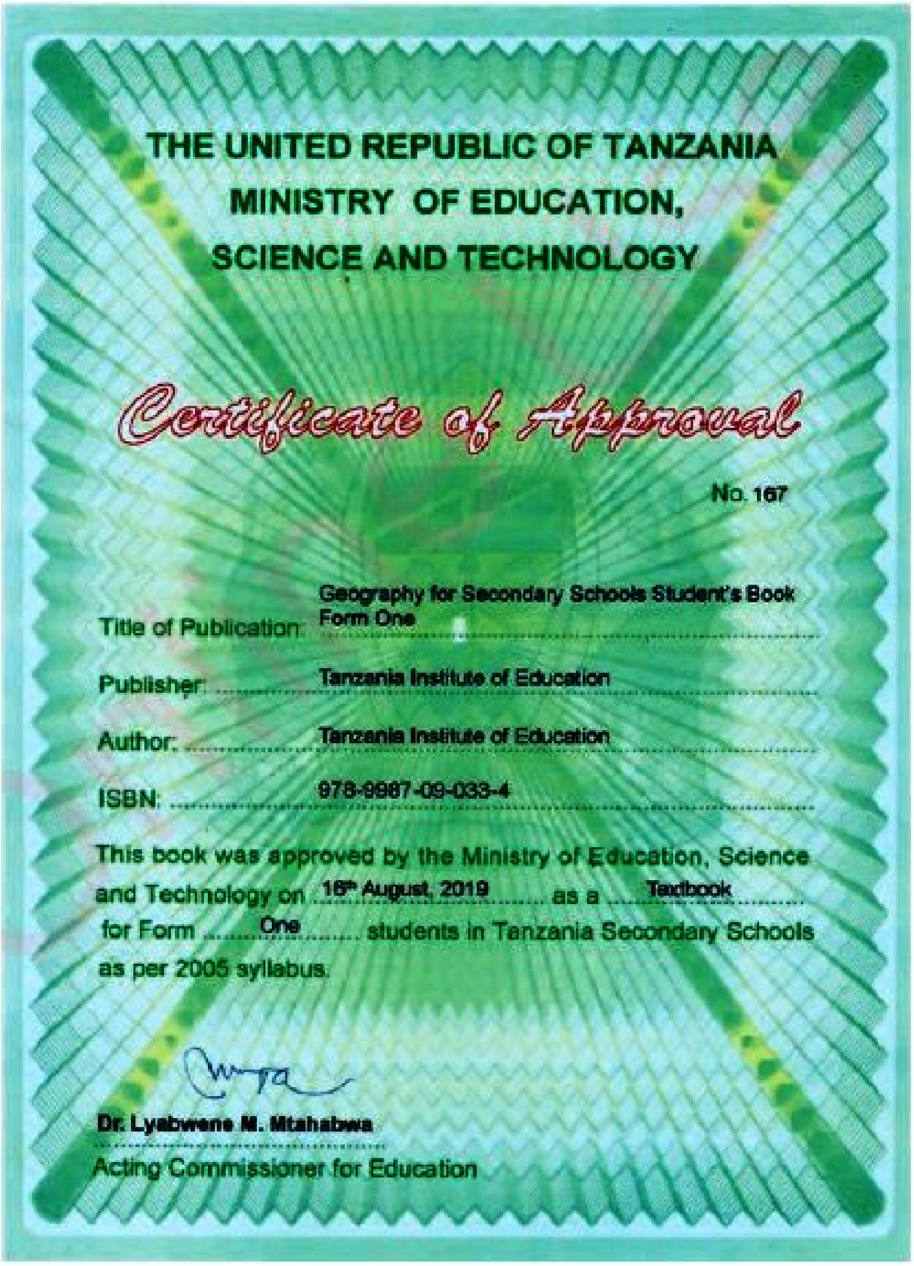
Geography

for Secondary Schools

Student's Book
Form One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Preface

This book, *Geography for Secondary Schools*, is written specifically for Form One students in the United Republic of Tanzania. The book is prepared according to the 2005 Geography Syllabus for Ordinary Secondary Education Form I-IV, issued by the Ministry of Education and Vocational Training.

The book is divided into five chapters, which are: The concept of Geography, The solar system, Major features of the earth's surface, Weather and climate, and Map work. Each chapter comprises illustrations, activities and exercises. Learners are encouraged to do all the activities and answer all the questions. This will enhance their understanding and promote acquisition of the intended skills and competencies for this level.

Tanzania Institute of Education

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Chapter One

The concept of Geography

Introduction

The world we live in comprises natural and man-made features. Geography describes the earth, the relationships between people and the environment, and the distribution of natural and man-made features. In this chapter, you will learn about the meaning of Geography, branches of Geography, interrelationships between different geographical phenomena, and the importance of studying Geography.

The meaning of Geography

The word "geography" comes from two Greek words "*geo*" which means "*The earth*", and "*graphien*" or "*grapho*" which means "to draw", "describe" or "write". The two words formed the word "*geographien*" which was later accepted into the English language as "Geography". Therefore, *Geography* is the science that describes the earth. It started as a study concerned with the simple description of the earth in words, using maps and statistics. The description involved both the physical earth and everything found in it such as plants, animals, people, and water bodies.

Thus, "Geography" can be defined as *the study of the interrelationship between human beings and the enviroment over time and space*. Geography helps us to understand the relationship between human activities and the environment. The word *environment* refers to the world and its surroundings where people, plants and animals live.

The earth includes land, water bodies and air where human beings carry out their daily activities. Various activities including fishing, swimming and sailing take place on water bodies. Cultivation, livestock keeping, lumbering, construction of infrastructure such as buildings, roads, railways and playing grounds take place on the land. Drilling wells and some mining activities take place in the interior of the earth. Aviation takes place in the atmosphere.

Geography describes how human beings interact with the environment and how different natural features are formed and distributed. It also explains the distribution of human activities on the earth's surface. Therefore, Geography focuses on the study of the earth as the home to people where they establish settlements and utilize space and resources.

The branches of Geography

Geography as a subject has two major branches, namely: *physical geography* and *human geography.*

Physical geography studies natural features of the earth. It focuses on the structure of the earth, atmospheric processes and the formation and distribution of landforms such as mountains, valleys, rivers and plateaus. It also studies the distribution of plants and animals (flora and fauna) as well as weather and climate.

Human geography studies man-made features found on the earth's surface. It also studies the interaction between human beings and the environment. It focuses on the distribution of people, settlements and human activities such as agriculture, mining, manufacturing, transport and communication. Furthermore, it studies human population aspects such as population structure and composition, distribution, and growth.

Each branch of Geography has a *practical* aspect. *Practical geography* enables learners to acquire practical skills that enhance their ability for interpreting both physical and human geography. Practical geography includes map work (reading and interpretation), quantitative methods, research techniques, surveying and photography. Figure 1.1 is a diagrammatic representation of the major branches of Geography.

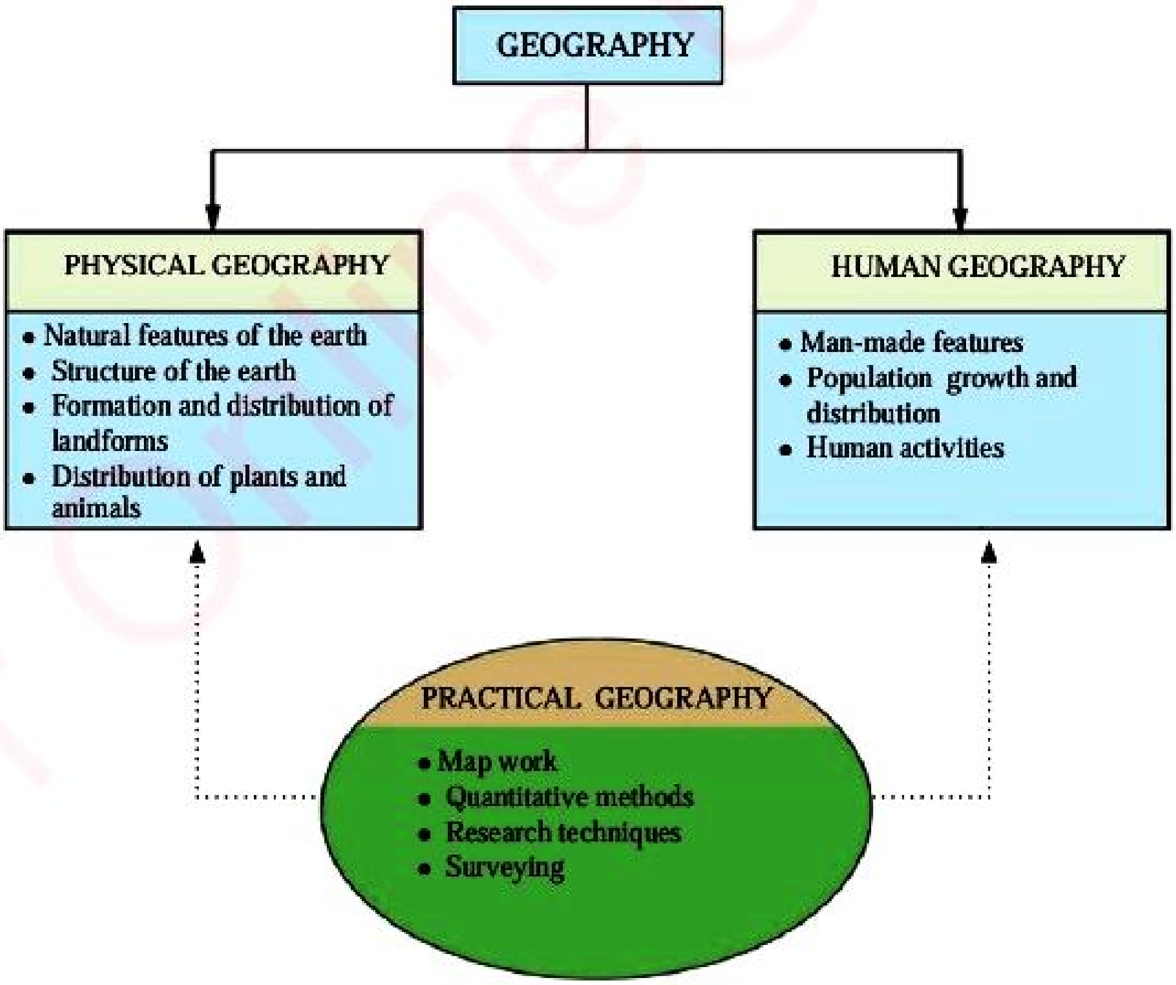


Figure 1.1 Major branches of Geography

The interrelationship between geographical phenomena

Our planet Earth consists of natural and man-made features. Features that support life on earth include water, air, light and soil. Human beings, animals and plants depend on these features for their survival. Therefore, there exist interactions and interrelationships between these geographical phenomena. The centre of the interrelationship is a human being who, to a large extent, uses the environment for his or her basic needs.

The phrase geographical phenomena refers to features, events or situations observed in the environment whose cause or explanation is of geographical interest. For example, drought, soil erosion, water pollution, floods and forest fire, are some of the negative geographical phenomena. The climate of an area influences the type of soil, the crops grown, livestock keeping, population distribution and settlements.

Human beings obtain their needs from nature. In so doing, they change the environment through, for example, land reclamation, deforestation and building activities. These activities impact on the environment. For example, extensive deforestation and overgrazing expose the land to agents of erosion. In turn, eroded land becomes unproductive for agriculture, which may lead to food shortage.

The environment provides a habitat for living things. Seas, oceans, lakes and rivers are home to aquatic species. Land provides the soil for growing plants. These plants are food for animals and human beings. There is also a strong relationship between the climate of a place and the type of food and cash crops grown. For example, drought-tolerant crops are grown in areas with little rainfall, whereas trees and some root crops grow well in areas with plenty of rainfall.

Likewise, the temperature of a place influences the way people dress. For example, in cold areas such as Arusha, Iringa, Njombe and Mbeya, people put on heavy jackets unlike those of Dar es Salaam and Tanga who put on light clothes.

Activity 1.1

Visit an area nearby your school and list down five human activities carried out.

The importance of studying Geography

Studying Geography has the following importance:

(a) It increases awareness of our country, its boundaries and resources as our national heritage.

(b) It promotes proper use of the available resources. Studying Geography helps people develop skills and capabilities that will help them make informed decisions on the use, management and protection of natural resources, thus improving their standard of living.

(c) It develops methods and skills of observing, measuring, recording and interpreting various geographical phenomena. These skills help us to generate scientific knowledge that enables us to predict outcomes of different processes and activities for appropriate decision-making.

(d) It helps us understand social and economic relations between countries and share ideas and experiences in solving related problems. This understanding is achieved by studying a variety of resources, economic activities, technology, and trade, as well as their interactions.

(e) It equips us with skills for environmental conservation. These skills are for appropriate use of environmental resources, and methods for managing associated problems for the wellbeing of the present and future generations.

(f) It equips us with practical skills and knowledge that are relevant for employment in various fields, for instance map making (cartography), teaching and research, surveying, land use planning, natural resources management, conducting environmental impact assessments (EIAs), aviation, navigation, surface transport and tourism industry.

Activity 1.2

(a) Walk around your school or home environment. Identify and list down any four geographical features.

(b) Work in pairs and discuss the relationship between the features you have identified.

Exercise 1. 1

Answer the following questions:

1. Tick (√) the phenomena that require a specific geographical knowledge.
   (a) Weather forecasting
   (b) Map-making and interpretation
   (c) Planning for the location of agricultural activities
   (d) Quarrying
   (e) Mountain climbing
   (f) Preaching
   (g) Environmental impact assessment for a development project
   (h) Reading books
   (i) Caring for HIV patients

2. Mention four job opportunities that can be obtained after studying Geography.

3. (a) Pictures (a) to (f) represent different activities that require geographical knowledge and skills. Write the correct letter of the picture against its corresponding activity.

Activity	Picture letter
(i) Aircraft piloting	
(ii) Tree planting	
(iii) Scuba diving	
(iv) Land surveying	
(v) Mountain climbing	
(vi) Cartography	

(b) List any other four human activities that require geographical knowledge and skills.

4. For each of the following statements, write letter **T** for a correct statement and letter **F** for a false one:

(a) Geography deals with the way human beings interact with the environment in the course of their development.

(b) Movements of people from one location to another do not involve geographical knowledge.

(c) The earth's surface consists of land, water and the atmosphere.

(d) Physical geography is a study of man-made features on the earth's surface.

(e) Drilling water and oil from underground is not considered as human interaction with the earth's surface.

5. Beside each statement, write letter **A** if the statement refers to physical geography, **B** if it refers to human geography, and **C** if it refers to practical geography:

(a) My uncle studies the behaviour of stars in the sky.

(b) Soon we will begin manufacturing cement.

(c) An engineering company is constructing a railway line.

(d) People migrate to urban areas because of poor living conditions in rural areas.

(e) Nowadays people are more involved in trade than in livestock-keeping as it used to be in the nineteenth century.

(f) The last volcanic eruption created a crater on top of the mountain.

(g) People clear forests for wheat production.

(h) Drawing a map to show the distribution of natural features in Tanzania.

(i) Depths of valleys change overtime.

6. In four points, explain the importance of studying Geography.

Chapter Two

The solar system

Introduction

The solar system comprises planets and other solid objects. The sun is at the center of the solar system. All planets and other solid objects revolve around the sun. The sun is the main source of all energy on earth. In this chapter, you will learn about the concept of the solar system, the sun, the solar energy, the planets and other bodies around the system. You will also learn about the shape and size of the earth, the earth's movement, and the parallels and meridians.

The concept of the solar system

During the day, the sun shines and gives light to the planet Earth, which is important to sustaining life. Looking at the sky at night, you will see stars twinkling and at times bright objects moving. All that we see in the sky forms part of the solar system. The word "solar" comes from a Greek word "sol", which means the sun. The solar system refers to the arrangement of planets and other solid objects in space in relation to their positions from the sun. Components of the solar system are the sun, the moon, the stars, the earth and other planets. Other components of the solar system include asteroids, meteors, comets and natural satellites.

All these objects found in space form an arrangement in relation to their positions from the sun and revolve around the sun (Figure 2.1). As they revolve, they are kept in their orbits by the sun's powerful force of gravity. An orbit is an elliptical path through which heavenly bodies revolve around the sun.

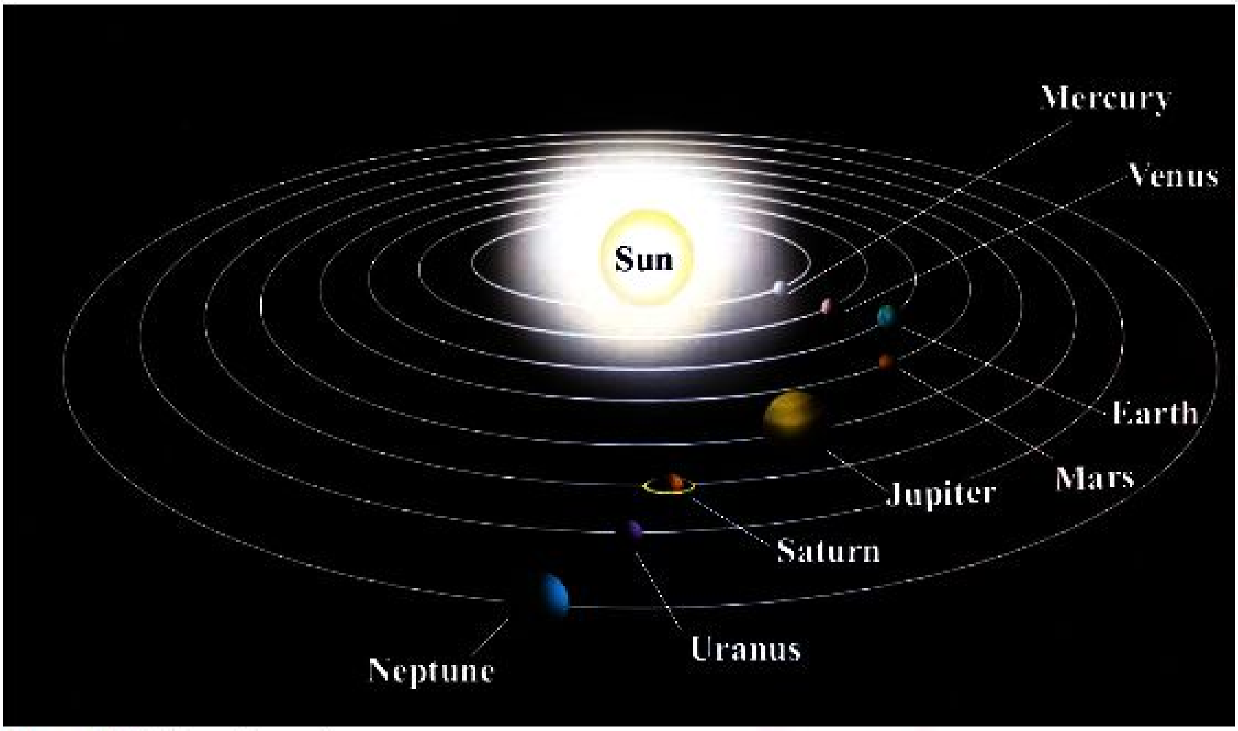


Figure 2.1 The solar system

There are eight planets in the solar system. These are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. The Earth has one moon which revolves around it. Some planets also have moons which revolve around them. Moons are natural satellites. All the planets revolve around the sun, each following its own path known as an orbit. Orbits are not true circles but imaginary paths of elliptical shapes. They are arranged in such a way that no orbit crosses the path of another.

Exercise 2.1

A: Study Figure 2.1 and then choose the most appropriate answer:

1. How many planets are in the solar system?
   (a) seven (b) eight (c) nine
   (d) ten (e) three
2. Which of the following planets is closest to the sun?
   (a) Earth (b) Jupiter (c) Mars
   (d) Mercury (e) Neptune
3. Which of the following planets is furthest from the sun?
   (a) Neptune (b) Venus (c) Mars
   (d) Earth (e) Mercury
4. What is the position of the earth from the sun?
   (a) second (b) third (c) fourth
   (d) last (e) the last but one

B: Describe the following terms:

1. Planet
2. Sun
3. Orbit
4. Solar system

C: Why are planets not colliding with one another as they revolve around the sun?

D: Draw a well-labelled diagram of the solar system.

The components of the solar system and their importance

The solar system is made up of several components. The main ones are *the sun, planets, satellites, asteroids, meteors, comets,* and *inter-planetary dust* and *gases.*

The **sun** is the main source of energy, which is called solar energy. The energy from the sun generates heat and light that are essential for living organisms. It is also responsible for the earth's weather and climatic conditions.

Meteors are small solid objects from outer space. They are seen as bright light crossing the sky at night at a high speed. At times, they fall to the earth surface and become meteorites which attract tourists. Examples include the Mbozi Meteorite in Songwe region in Tanzania and the Great Meteorite in Arizona, United States of America (USA).

The **earth** is the only planet known to support life. It has the necessary requirements such as water and air for animals and plants to survive.

The **moon** is a natural satellite which reflects the sun's light to the earth during the night. The moon's gravitational pull affects life on earth by creating tides in the oceans.

Asteroids are the source of meteorites, and therefore a source of surface deposits of metals such as iron and nickel.

The sun

The sun is at the centre of our solar system. It looks bigger because it is closer to the earth than other stars. The sun is larger than the earth. Its diameter is about 1.4 million kilometres and its mass is about 330,000 times greater than that of the earth. The sun is composed of about 75 percent hydrogen and 23 percent helium. The remaining 2 percent consists of carbon, oxygen, silicon, iron and other chemical elements.

The sun is so hot that nearly all the molecules are broken into their separate atoms and all are mixed into a single hot gas. Its average surface temperature is about 6000 °C. It is hotter in the interior where its temperature is about 15000000 °C. The sun is the main source of all light and heat that the planets receive.

The solar energy

Solar energy refers to the radiant light and heat from the sun. The sun is the main source of energy on the earth. Sun rays transfer energy from the sun to the earth's surface through a process called radiation. This energy can be harnessed using technologies such as solar heating, thermal energy and photovoltaics (conversion of light into electricity).

Uses of solar energy

Solar energy is used in the following ways:

(i) Drying clothes, grains, fruits and meat.

(ii) It is the source of heat and light which are essential for seed germination.

(iii) Plants use energy from the sun to manufacture their own food through the process known as photosynthesis. In this process, green plants and certain other organisms convert light energy into chemical energy that can later be released to provide energy for the organism's activities.

(iv) Human bodies absorb solar energy and convert it into Vitamin D which is useful for human health.

(v) Solar energy is important in the formation of rainfall. It evaporates water from water bodies which rises, cools and condenses to form clouds and eventually rainfall.

(vi) Solar energy is an alternative source of energy to fossil fuels that are harmful to the environment. It is also an alternative to hydroelectric power (HEP) that is not reliable and requires a lot of money to produce. Figure 2.2 shows some solar panels that are used to trap solar energy to generate electricity.

Figure 2.2 Solar panels for electricity generation

source: www.rgsenergy.com/how-solar-panels-work

(vii) Solar energy can be used for domestic and industrial purposes. In Tanzania, solar energy is increasingly being used as a source of electricity, particularly in areas with no access to other sources of energy. In the United States of America (USA), China and Japan, solar energy is used for cooking, lighting and heating. For example, solar ovens and solar cookers are used for heating and cooking (see Figures 2.3 and 2.4).

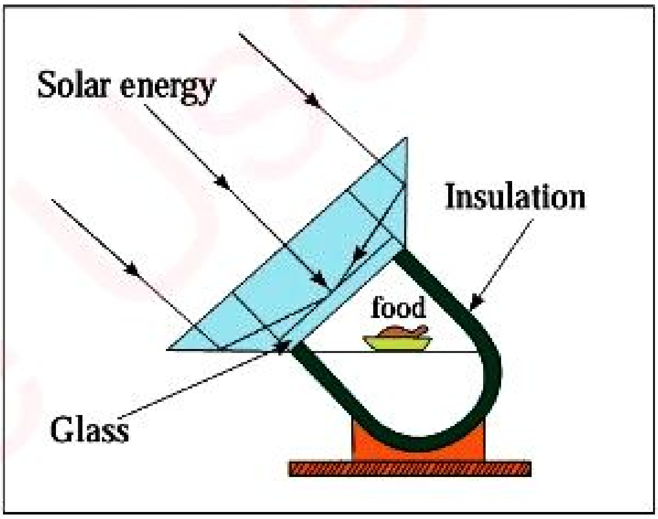


Figure 2.3 A solar oven

Figure 2.4 A solar cooker

Source: https://www.amazon.in/Sun-Mitra-Square-Shape-Cooker-525X525mm/dp/B06Y5P8LBV

Solar energy and environmental conservation

The majority of people in Tanzania depend on firewood and charcoal as their main sources of energy for domestic use. These sources are widely used because they are readily available and affordable to many people. However, their continued use contributes to the degradation of the environment through air pollution and deforestation. Solar energy is more environmentally-friendly than charcoal and firewood because it does not pollute the environment or contribute to deforestation.

The use of solar energy minimises the use of **fossil fuels** such as coal, petroleum, diesel and kerosene, thus reducing environmental pollution via, for example, the emission of greenhouse gases from burning fuel. Consequently, the use of solar energy minimises the impact of **climate change** in the long-term.

Solar energy is renewable because it can be used several times without being exhausted compared to firewood and charcoal which become depleted with use. Furthermore, Tanzania is located within the **tropics** where solar energy can be harnessed easily and is readily available throughout the year.

Increased use of solar energy instead of fossil fuels, charcoal and firewood will increase the availability of clean air and water, food, fertile soils, medicines and recreational services from the environment. The situation will also help in pollination, honey production, and pest and disease control. The use of solar energy, therefore, contributes to environmental conservation as it reduces environmental degradation.

Contribution of solar energy to the emancipation of women

In Tanzania, especially in rural areas, the main source of fuel is firewood. Fetching firewood is mainly carried out by women and girls. They usually fetch the firewood far from home, which is a tedious task. The use of solar energy for domestic purposes contributes to women's emancipation. Women emancipation is a process that frees women from social, political, economic and technological limitations. The use of solar energy contributes to women's emancipation in the following ways:

(i) it reduces the time spent on fetching firewood. This means that women would have more time to take part in other activities; in addition young girls will get time for study.

(ii) It reduces health risks associated with the use of fuel-wood. Fuel-wood emits smoke during cooking, which may cause problems in their respiratory system.

(iii) It reduces the risk of being attacked by wild animals while collecting firewood in forests.

(iv) It reduces the financial burden of the ever-increasing oil prices. For example, women and girls can save money intended for kerosene to buy other essential household items.

(v) It reduces the risk of violence against women such as sexual harassment associated with walking over long distances to collect firewood.

Exercise 2.2

(a) Using recommended sources (for example books), find out why people need solar energy.

(b) Discuss six advantages of using solar energy.

The planets

Planets are bodies that revolve around the sun. The planets of our solar system are *Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus* and *Neptune*. The first four planets from the sun are inner planets whereas the remaining four are outer planets because they are located further away from the sun. These planets have specific positions in the solar system. As they revolve around the sun, they appear to move among the stars. That is why the Greeks called them planets, which means "wandering stars".

All planets revolve around the sun on the same plane and direction, each following its own orbit. The time it takes for a planet to complete orbiting the sun depends on its distance from the sun (Table 2.1). Light and heat on the planet come from the sun. Hence, the temperature on the planets depends on their relative distances from the sun.

Table 2.1 Some characteristics of the planets

No	Planet	Approximate distance from the sun (million km)	Number of moons per planet	Average Temperature	Period per orbit	Surface area of each planet in km²
1	Mercury	58	0	430 °C	88 days	74.8 mill
2	Venus	108	0	462 °C	225 days	460.2 mill.
3	Earth	150	1	15 °C	365 days (1 year)	510.1 mill.
4	Mars	228	2	-63 °C	1 year and 322 days	144.8 mill.
5	Jupiter	778.5	79	-145 °C	12 years	61.42 bill.
6	Saturn	1434	62	-178 °C	29 years	42.7 bill.
7	Uranus	2871	27	-216 °C	84 years	8.038 bill.
8	Neptune	4495	14	-214 °C	165years	7.618 bill.

Mercury

Mercury revolves at a distance of about 58 million kilometres from the sun. It is the closest planet to the sun and the smallest planet in our solar system. Its average surface temperature is 430 °C. It is called a boiling planet because of its closeness to the sun which is extremely hot. This planet has no natural satellite.

Venus

Venus revolves at a distance of about 108 million kilometres from the sun. Its size is close to that of the planet Earth. It is the second planet from the sun. This planet has no natural satellites. It is the hottest planet, with an average surface temperature of 462 °C, most likely because of the high amount of greenhouse gases in its atmosphere.

Earth

The planet Earth revolves at a distance of about 150 million kilometres from the sun. It has an average surface temperature of 15 °C. It is the only planet in the universe known to have geological and biological activities. Therefore, the earth is the only planet which supports life. The earth has one natural satellite known as the moon.

Mars

Mars revolves at a distance of about 228 million kilometres from the sun. It is smaller than the earth and venus. Its atmosphere is mainly composed of carbon dioxide and it has two natural satellites.

Jupiter

This planet revolves at a distance of about 778.5 million kilometres from the sun. Its atmosphere is composed of hydrogen and helium gases. It is the largest planet in the solar system. It has 79 natural satellites.

Saturn

This planet revolves at a distance of about 1,434 million kilometres from the sun. It is distinguished by its extensive ring system and has 62 natural satellites. The ring system is composed of solid materials such as dust. The ring system is a distinctive feature of the planet.

Uranus

Uranus revolves at a distance of about 2,871 million kilometres from the sun. Its atmosphere is mainly composed of hydrogen, helium, and methane. It has 27 natural satellites.

Neptune

This planet revolves at a distance of about 4,495 million kilometres from the sun. It is composed of hydrogen and helium. It also contains small amount of water and methane. It has 14 natural satellites.

Other bodies in the solar system

Apart from the sun, moon and planets, other bodies exist in the solar system. They are smaller than the planets. These include *comets, asteroids, meteors* and *satellites*.

Comets

A comet is a mass of ice, frozen gases, rock particles and dusts, which moves around the sun. It looks like a bright star with a tail. Comets are visible in the sky as moving objects with leading heads and bright tails. Comets go around the sun far beyond the limit of Neptune (Figure 2.5). They become visible from the earth only when they come near the sun.

Figure 2.5 A comet

Source: http://medium.com/starts-with-a-bang/this-is-why-comets-grow-an-eerie-green-color-61b7128e2f01

Asteroids

Asteroids are solid heavenly bodies in the solar system revolving around the sun. They are also called Planetoids because they look like planets. An asteroid belt is found between Mars and Jupiter. The largest asteroids are called Ceres. They have a diameter of less than 800 kilometres. Asteroids are only visible via a telescope because they are very far away from the earth (Figure 2.6).

Figure 2.6 Asteroids

Source:https://news.wsu.edu/2019/07/16/speeding-science-near-earth-asteroids/

Meteors

Meteors are pieces of rocks falling from outer space. They become visible between 110 and 145 kilometres from the earth's surface. These rocks burn as a result of friction with the atmosphere. However, some do not burn completely and reach the earth's surface. When they reach the earth's surface, they are known as meteorites. There are two meteorites in Tanzania. One is found in Ndolezi Village, Mbozi District in Songwe Region, about 65 kilometres south-west of Mbeya City (Figure 2.7). This meteorite was officially discovered in the 1930s. Previously, it was only known to the local people.

Figure 2.7 The meteorite in Mbozi, Songwe Tanzania

Source: http://ourproudlytanzania.blogspot.com/2016/06/kifahamu-kwa-kina-kimondo.html

The other less spectacular site of meteorite is found in Malampaka, Maswa District in Simiyu Region. This meteorite fell at Malampaka in 1930. When meteors strike the earth's surface, they may cause depressions. An example of such depressions in the world is the Great Meteor Depression in Arizona in the United States of America which is 150 metres deep and about one kilometre wide (Figure 2.8).

Figure 2.8 The great meteor depression in Arizona, USA

Source:https://www.space.com/834-mystery-arizona-meteor-crater-solved.html

Satellites

A satellite is a body that moves around a planet or any other body larger than itself. There are natural and artificial satellites. There are about 185 known natural satellites in the solar system. The moon is the largest known natural satellite of the planets. Currently, only six planets are known to have natural satellites. These planets and their number of satellites are Earth (1), Mars (2), Jupiter (79), Saturn (62), Uranus (27), and Neptune (14). The artificial or man-made satellites which revolve around the earth are mainly for weather forecasting, taking photographs, collecting data for map making and for telecommunication. Satellite dishes used at home receive and transmit information from communication satellites.

Exercise 2.3

A: Choose the correct answer and circle its letter:

1. Which of the following bodies is at the centre of the solar system?
   (a) Sun (b) Earth (c) Moon
   (d) Meteor (e) Planet

2. Which of the following is not true about the uses of solar energy?
   (a) Solar energy is used for heating homes.
   (b) Solar energy is used for drying clothes and grains.
   (c) Solar energy is used in heavy industries.
   (d) Solar energy is used as a source of light.
   (e) Solar energy is used to drive carts.

3. Which of the following statement is true regarding satellites?
   (a) All satellites are bigger than the earth.
   (b) All planets have satellites.
   (c) Some planets have satellites, some do not.
   (d) The moon is a satellite that produces its own light.
   (e) Saturn has no natural satellite.

4. Which of the following is true regarding the earth?

(a) It is the third largest planet in the solar system.

(b) It is the only planet that is known to support life.

(c) It revolves around the sun once in every 364 days.

(d) It revolves on an orbit that crosses orbits of other planets.

(e) It has an average temperature of about 100 °C.

5. Which of the following is true regarding planets?

(a) All planets revolve around the sun.

(b) They take 364 days to complete one revolution.

(c) All planets revolve around the sun on the same orbit.

(d) The temperature of the planets increases with increasing distance from the sun.

(e) All planets rotate around the sun.

B: Answer the following questions:

1. Differentiate between meteorites and asteroids.

2. List four domestic uses of solar energy.

C: Match each statement in Column A with its corresponding item in Column B:

Column A	Column B
1. Composed of the sun, planets and other bodies	(a) The solar system (b) Comets (c) The sun (d) The earth (e) Neptune (f) Venus (g) Mercury
2. Located at the centre of the solar system	
3. The furthest planet from the sun	
4. Objects with leading heads and bright tails in the sky	
5. The closest planet to the sun	

The earth

The earth is the third furthest planet from the sun and ranks fifth in size. The distance of the earth from the sun is about 150 million kilometres. The earth is made up of the atmosphere (air), hydrosphere (water bodies), lithosphere (solid and molten materials), and the biosphere (living things). About three quarters of the earth's surface is covered by water. Currently, the earth is the only planet in the solar system with water bodies. The earth is the planet on which we live.

The shape and size of the earth

The shape of the earth is a flattened sphere. A flattened sphere is known as an oblate spheroid (geoid). The flattening of the earth is very slight as the measurements in the north-south and east-west distance indicate. The distance through the centre from the North Pole to the South Pole is 12,713 kilometres whereas the distance through the centre of the earth at the equator is 12,757 kilometres. The circumference of the earth at the equator is about 40,000 kilometres (Figure 2.9).

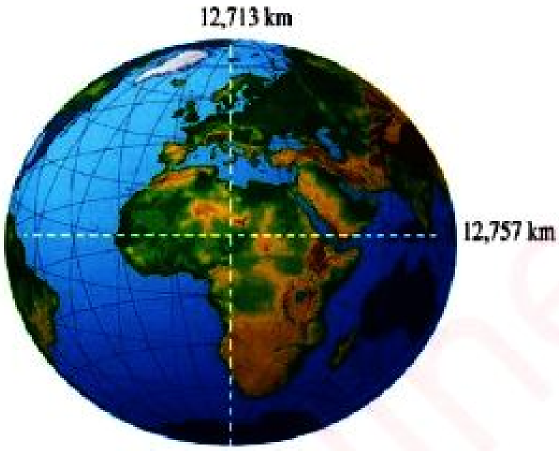


Figure 2.9 Size and shape of the earth

Evidence of the earth's shape

There is enough evidence to show that the earth is spherical. The evidence includes the following:

(i) **Sunrise and sunset**

The sun rises and sets at different times in different places of the earth. People in the east see the sun earlier than those in the west due to the earth's rotation from west to east (Figure 2.10(a)). If the earth was flat, the whole world would have sunrise and sunset at the same time (Figure 2.10 (b)).

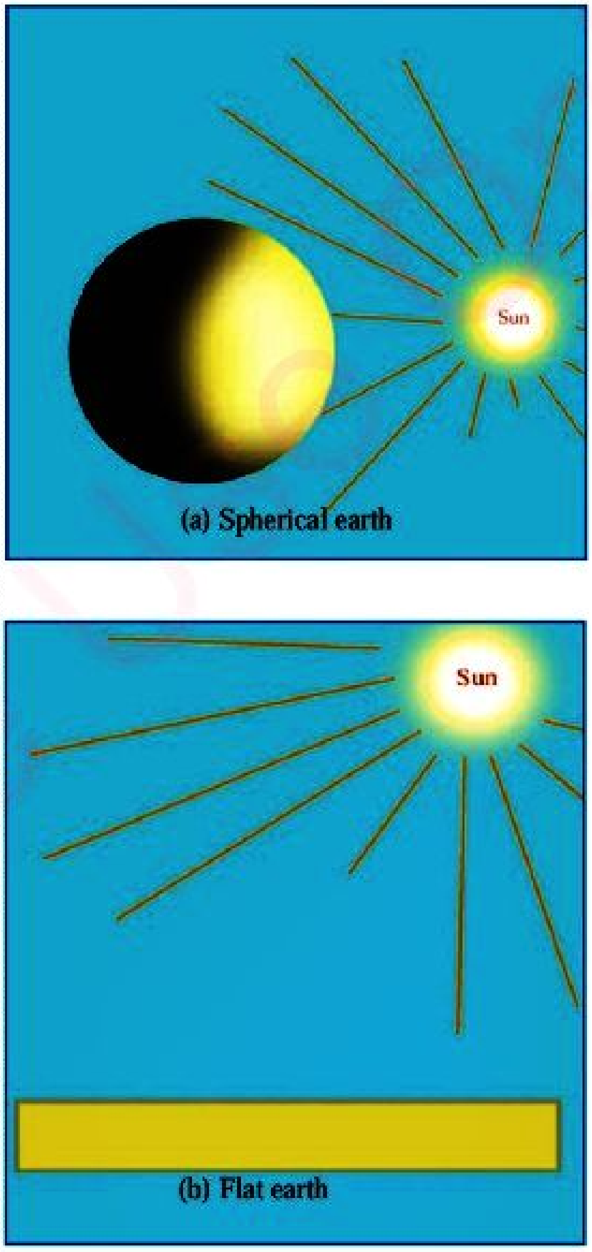


Figure 2.10 (a & b) Sun rise on the spherical earth and the flat earth

(ii) **Circumnavigation of the earth**

If you travel from a certain point on the earth by going straight around the earth, you will eventually come back to the point of origin.

This concept was proved by the first navigator Ferdinand Magellan who sailed around the world from 1519 to 1522. Magellan in his voyage did not encounter any abrupt edge on earth's surface over which he would fall. This journey around the earth is called circumnavigation (Figure 2.11).

Figure. 2.11 Circumnavigation of the earth

(iii) Aerial photograph of the earth

A photograph taken by airplane or images captured by artificial satellites from the air show that the earth is curved (Figure 2.12).

Figure 2.12 An aerial photograph of the earth

Source: https://fineartamerica.com/featured/earth-from-space-africa-view-johan-swanepoel.html

(iv) Ship's visibility

The visibility of an arriving ship which is far away starts with the flag, then the mast and eventually the whole ship as it nears the coast. When the ship moves

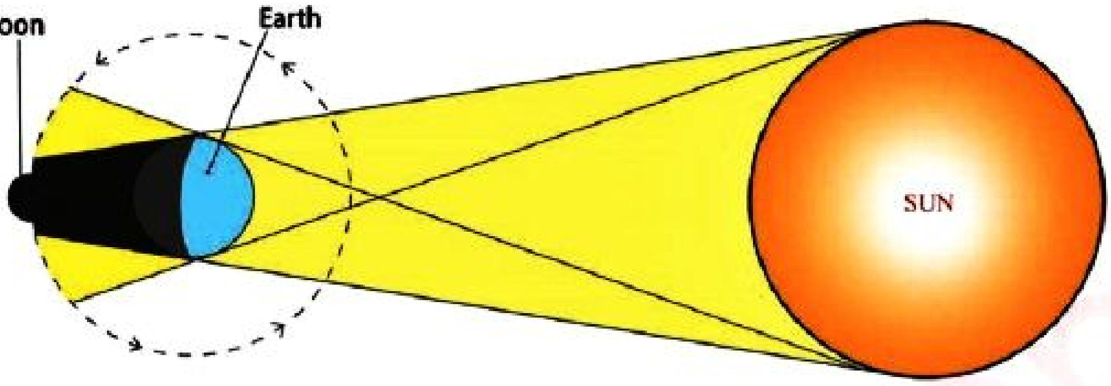


Figure 2.14 Lunar eclipse

(i) The earth's curved horizon

The earth appears to have a curved horizon when viewed from a high cliff, a plane or a high building. The earth's curved horizon widens as the observer's altitude increases until it becomes circular (Figure 2.15).

Source: www.photosearch.com

Figure 2.15 The earth's curved horizon

The earth's movement

The earth is in motion all the time. The earth has two movements, namely rotation and revolution.

Rotation of the earth

The term *rotation* means the spinning of a body on its axis. An axis is an imaginary line joining the North and South poles through the centre of the earth. The earth rotates on its axis in an anticlockwise direction, from West to East through 360° in 24 hours (Figure 2.16). This means that the earth takes one hour to rotate through 15°, which is equal to 4 minutes for every 1°.

Figure 2.16 The earth's rotation

Evidence of the earth's rotation

(i) The phenomenon that the sun moves from the east to the west is absolutely not true because the sun as the central body of solar system is stationary. Instead, what moves is the earth, which rotates from the west to the east. It is this movement which explains why the sun appears to rise from the east in the morning and set in the west during the evening. Therefore, the earth rotates on its axis from the west to the east.

(ii) At night, most of the stars appear to move across the sky from the east to the west. This proves that the earth is rotating from the west to the east.

(iii) When travelling in a fast-moving vehicle, we notice that trees and other objects appear to be moving in the opposite direction. This observation is similar to the movement of the earth in relation to the sun. Just like the individual moving in the bus, it is the earth and not the sun that rotates.

The earth's rotation changes from no movement to very rapid movement although we do not feel the motion because we move with it. At the equator, every point of the earth's surface moves eastwards at about 1,600 kilometres per hour. At latitude 40°, the speed is about 1,280 kilometres per hour. In the meantime, at the poles, the speed is 0 kilometre per hour.

Effects of the earth's rotation

When the earth rotates, the following happen:

(i) **Day and night**

The change between day and night is caused by the rotation of the earth on its axis. The side that faces the sun experiences the light from the sun (day) whereas the side that is not facing the sun at that time is in darkness (night). Therefore, as the earth rotates, its two parts alternate between light and darkness, respectively, hence the day and night sessions they experience in turns. As such, different places on the earth's surface experience sunrise, noon and sunset at different times in a day (Figure 2.17).

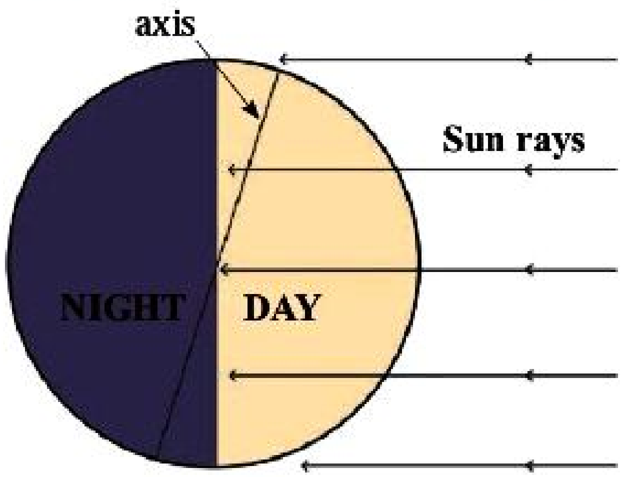


Figure 2.17 Day and night

(ii) Differences in time between places located at different longitudes

The earth's rotation results in different times for different locations. The difference in time is determined by longitudinal differences between two or more places. We have learned that the earth rotates from the west to the east making a circle of 360°. Then, how long will it take to turn 1°?

To find the answer to this question, we must divide 24 hours by 360°. But first, we will change the hours into minutes: 24 x 60= 1440. Thus, the earth goes through 360° in 1,440 minutes. To find how long it takes 1° to rotate, we divide 1,440 minutes by 360°. Therefore, the earth takes 4 minutes to turn 1°. As there are 60 minutes in 1hour, the earth will turn 15° in 1 hour.

(iii) Gain or loss of a day when crossing the International Date Line

The International Date line (IDL) is an imaginary line that was established in 1884. This line follows the meridian of 180° longitude except where it crosses land surface. It is located halfway round the world from the prime meridian (the zero degree longitude) established in Greenwich, England, in 1852. When travelling from the west to the east and you cross the IDL, you gain a day. Conversely, when you cross this line from the east to the west you lose a day (see Figure 2.31 in page 36). For example, if it is Thursday 3rd August 2:00 pm at 165° W, it will be Friday 4th August 2:00 am at 165° E.

(iv) Deflection of winds and ocean currents

The earth's rotation causes deflection of planetary winds and ocean currents. This means that they do not blow and flow in the intended direction. The planetary winds and ocean currents are deflected to the right in the northern hemisphere and to the left in the southern hemisphere (Figures 2.18a & 2.18b). This is summarised by Ferrel's Law which states that freely moving bodies are deflected to their right in the northern hemisphere and to their left in the southern hemisphere from their point of origin. This is evident in the deflection of winds and ocean currents.

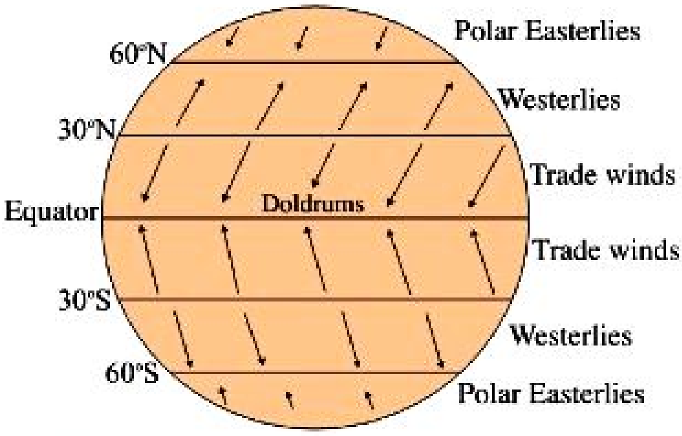


Figure 2.18 (a) Deflection of winds due to the earth's rotation

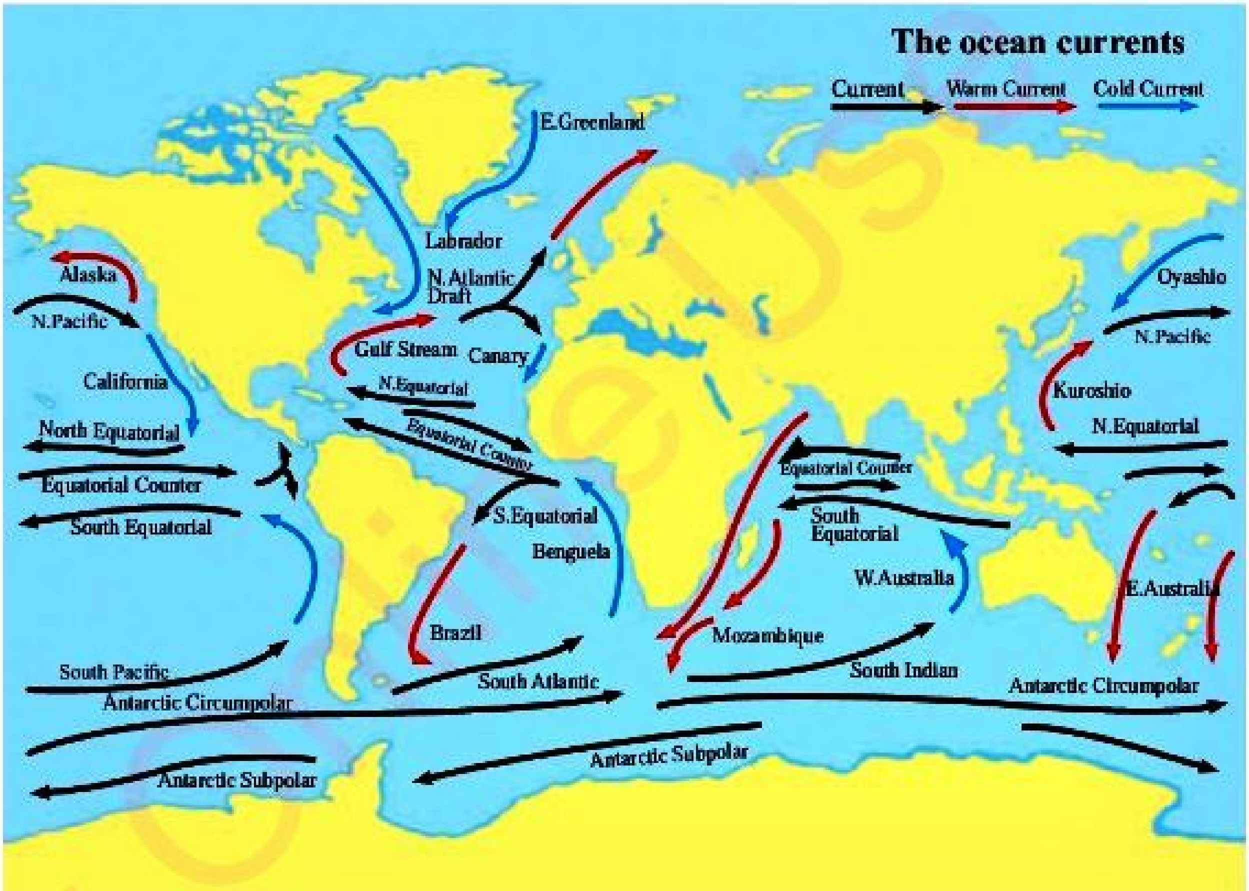


Figure 2.18 (b) Deflection of ocean currents

(v) **The daily rising and falling of tides**

The ocean tide is the rising and falling of the water level in the ocean (Figure 2.19). This is caused by gravitational attraction exerted by the sun and largely by the moon upon the rotating earth. When the sun, the moon and the earth are in a straight line, the ocean tide rises and when the sun, the moon and the earth are not in a straight line, the ocean tide falls. Tides are experienced at different times of the day and in different places on the earth's surface.

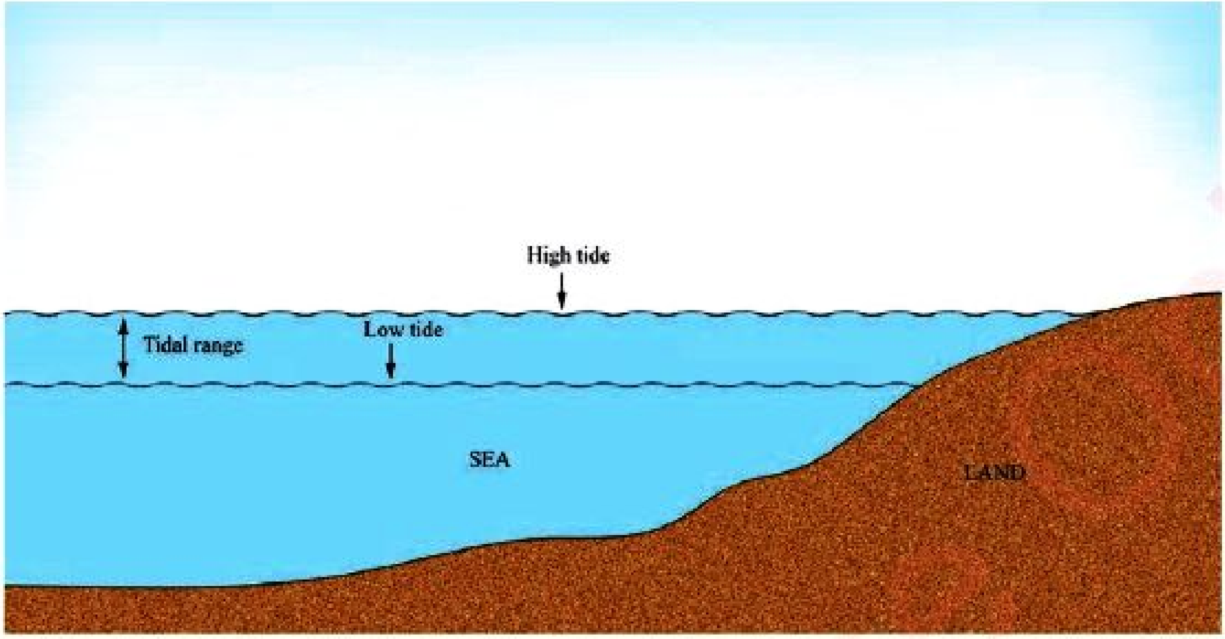


Figure 2. 19 Low and high tide levels of the ocean water

Revolution of the earth

The earth's revolution refers to the movement of the earth around the sun following its orbit. The speed of revolution is about 29.6 kilometres per second. The earth revolves around the sun for approximately 365 days a year. Anormal year has 365 days. The fraction days are not counted every year but is added once in 4 years to make a leap year of 366 days. The leap year occurs once in every four years, when February has 29 days instead of 28.

Effects of the earth's revolution

The revolution of the earth around the sun and tilting on its axis have the following effects:

(i) **Seasons**

A season is the main period of the year with a particular type of weather. Seasons are caused by the inclination of the earth's axis and the earth's revolution around the sun. The earth's axis is tilted at an angle of 66½° to the earth's orbital plane and it is always pointing to the same direction in space. In its revolution around the sun, one of the hemispheres is inclined towards the sun at one period of the year and away from it at another period of the year. For example, in June, July and August, the northern hemisphere tilts towards the sun, thus, it is Summer time. The same months in the southern hemisphere, it is Winter because the southern hemisphere tilts away from the sun. Spring and Autumn are short seasonal transitions between Summer and Winter, respectively.

Generally, there are four seasons in a year that are differentiated by temperature and rainfall characteristics. These seasons are Summer, Autumn, Winter and Spring. The four seasons are more pronounced in areas found between 23½° and 66½° of latitude north and south of the equator. Around 0° to 5° north and south of the equator, there would be no season because it experiences high temperature and rainfall throughout the year and the sun is almost overhead at those places throughout the year. However, due to variations in relief, seasonal variations are experienced. The area between 5° and 23½° north and south of the equator are characterised by hot-wet and cold-dry seasons. At the North Pole (NP) and the South Pole (SP), it is very cold throughout the year and the seasons cannot be distinguished easily.

In the northern hemisphere, summer months are June, July and August. Autumn months are September, October and November. The winter season occurs in December, January and February whereas Spring months are March, April and May. In the southern hemisphere, the summer months are December, January and February. Autumn occurs in March, April and May. The Winter season occurs in June, July and August whereas spring months are September, October and November (Figure 2.20). However, due to the presence of relief and oceans, these seasons do not occur in this sequence.

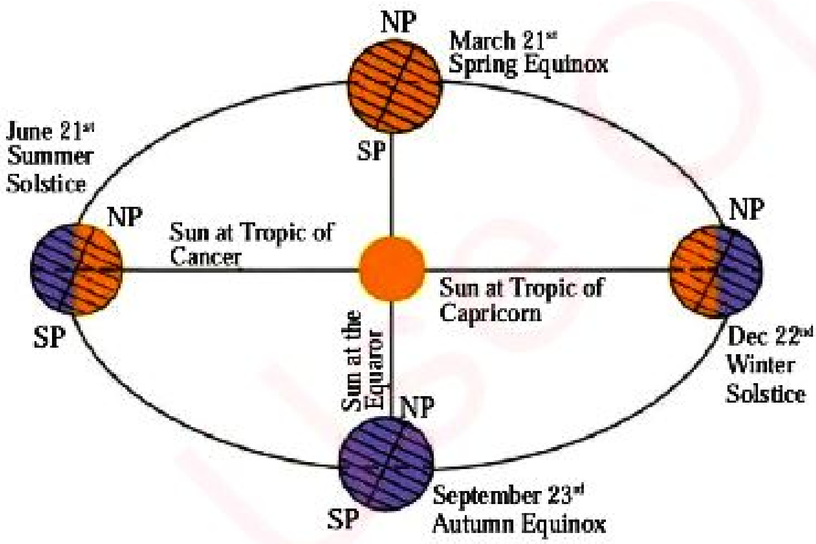


Figure 2.20 The four seasons of the year

(ii) Aphelion and perihelion

The earth revolves around the sun in an elliptical orbit. Due to the elliptical shape of the earth's orbit, the sun is closer to the earth at one point of the year than at another (Figure 2.21). The furthest position from the sun in the orbit of the earth is called aphelion. The earth is at aphelion each year on 4th July when it is 152 million kilometres from the sun. Perihelion occurs when the earth is nearest to the sun about 147 million kilometres from the sun. The earth is at perihelion each year on the 3rd of January.

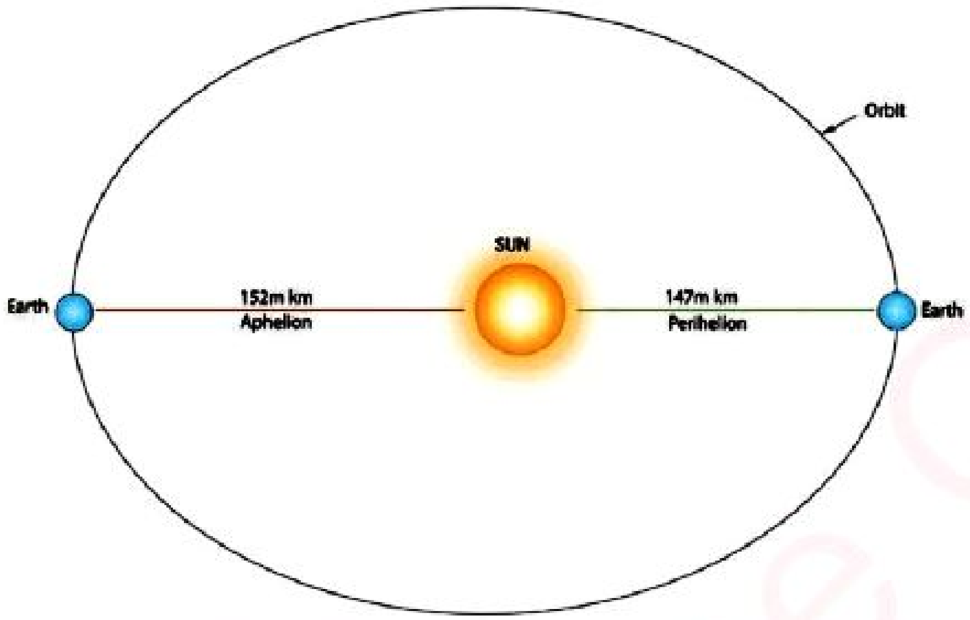


Figure 2.21 Perihelion and aphelion

(iii) Eclipses

An eclipse is a total or partial obstruction of light from the sun by either the earth or the moon. This occurs when the earth or the moon intercepts the light from the sun. There are two types of eclipses: the lunar and solar eclipse. The lunar eclipse is also known as the eclipse of the moon. It occurs when the earth passes between the moon and the sun, thus casting its shadow on the moon (Figure 2.22).

Figure 2.22 Eclipse of the moon

The solar eclipse is also known as the eclipse of the sun. It occurs when the moon passes between the earth and the sun. The moon throws its shadow over the earth (Figure 2.23). An eclipse of the sun is partial when only part of the earth is obscured by the shadow of the moon. The portion of the shadow that results when the light from the sun is partially blocked is called Penumbra. Moreover, when the light from the sun is completely blocked it forms the shadow called Umbra.

On 23rd October 1976, parts of Tanzania witnessed a total eclipse of the sun. In addition, partial eclipses occurred on 19th April 1977 and 14th October 2000. On 1st September, 2016, a total solar eclipse was witnessed in Rujewa, Mbarali District in Mbeya Region.

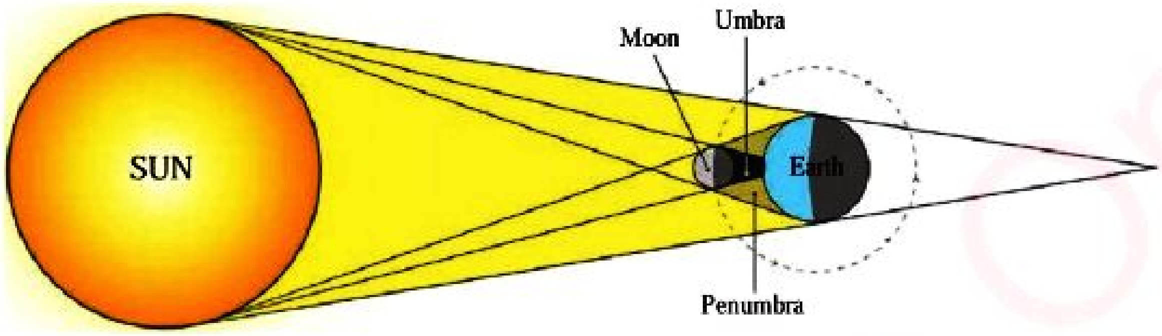


Figure 2.23 Eclipse of the sun

(iv) **Changes in the latitude of the overhead sun**

The overhead sun appears to move northwards and southwards between latitudes 23½° N and 23½° S, that is, between the tropics of Cancer and Capricorn. As a result, places between the tropics of Cancer and Capricorn experience overhead sun at different times of the year. The places south of the Tropic of Capricorn and north of the Tropic of Cancer never experience overhead sun at any time of the year (Figure 2.24).

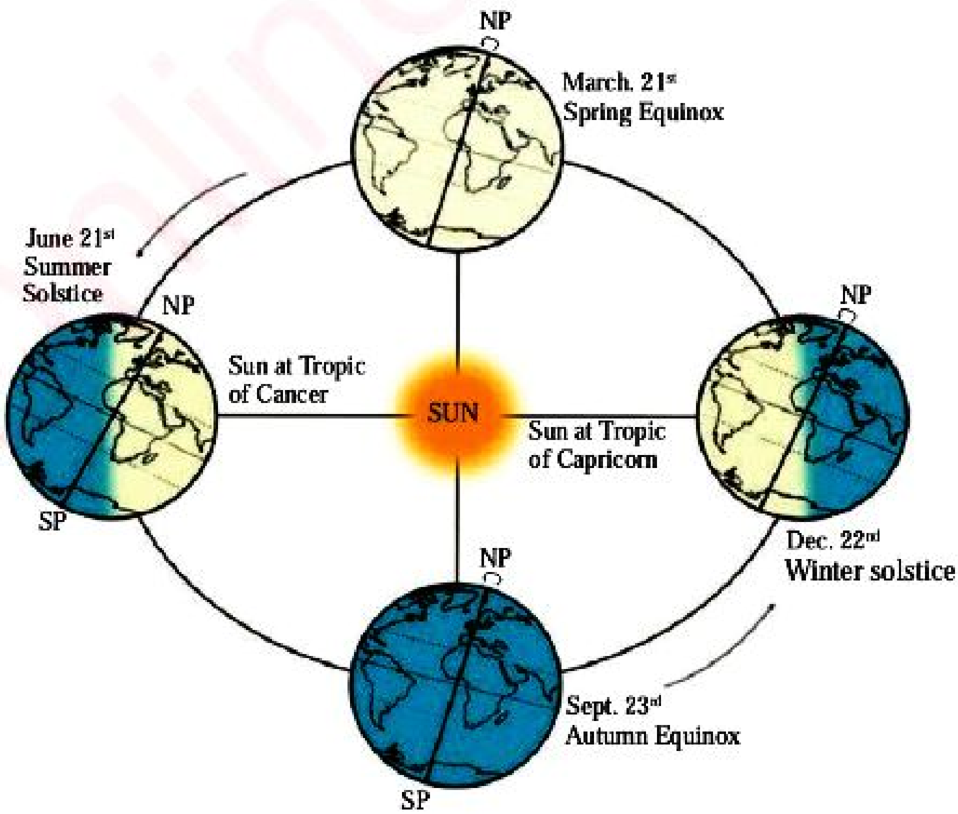


Figure 2.24 Changes in the latitude of the overhead sun

Solstice and equinox

The tilting nature of the earth's axis causes parts of its surface to receive different amount of sunlight at different times of the year. This situation results to seasons of the year and two phenomena which are solstice and equinox.

Solstice comes from the Latin word **solstitium** which contains two words: **Sol** means **sun** and **sistere** which means stand still. The solstice, therefore, literally means "**sun-stand still**". Solstice is a phenomenon that occurs when the earth poles are mostly inclined towards or away from the sun, causing the earth pole which is inclined to the sun to receive maximum sunlight. This makes the most inclined pole towards the sun to experience the longest day in the year. During this time, the sun is vertically overhead in respective tropic on specific dates. The southern hemisphere gets the maximum intensity of the sun's rays on December 22nd which is the Summer Solstice in the tropic of capricorn. At the same time, it is the Winter Solstice in the tropic of cancer. The northern hemisphere solstice occurs on June 21st commonly known as the Summer Solstice in the tropic of cancer. At the same time, it is winter solstice in the tropic of capricorn.

The **equinox** simply refers to equal lengths of days and nights. Due to the tilting of the earth's axis, there are only two times of the year when the sun is directly overhead at noon along the equator. This results in equal distribution of sun rays between the southern and northern hemispheres. The equinox occurs around March 21st and September 23rd of every year. The March equinox is referred to as vernal equinox in the northern hemisphere and autumnal equinox in the southern hemisphere. On the other hand, the September equinox is known as autumnal equinox in the northern hemisphere and vernal equinox in the southern hemisphere (Figure 2.24)

(v) **Varying lengths of day and night at different times of the year**

The lengths of day and night are not the same across the world because the earth's axis is inclined to its plane at an angle of 66½^{0}. Had the earth's axis been vertical to its orbital plane, all the parts of the earth would have the same duration of days and nights throughout the year.

Places along the equator experience equal day and night throughout the year, but northwards or southwards toward the poles, the lengths of day and night vary with latitude. For instance, when the overhead sun is in the northern hemisphere, the days are longer than the nights in that hemisphere. However, at latitude 66½° N (the Arctic Circle) and beyond, the sun does not set. At the North Pole, daylight is experienced for six months without sunset. During that period, the polar regions south of the Antarctic Circle (66½°S) experience prolonged six months of darkness and, vice-versa; they receive six months of day light as the North Pole experiences darkness.

Exercise 2.4

Choose and circle the letter of the phrase which completes the statement correctly:

1. Day and night are caused by:
   (a) Earth's rotation
   (b) Earth's revolution
   (c) Distance of the earth from the moon
   (d) Distance of the earth from the sun
   (e) Eclipse of the moon
2. Places on the East of Greenwich experience sunrise before places on the west because the earth:
   (a) Rotates from east to west
   (b) Rotates from the west to the east
   (c) Revolves around the sun
   (d) Is very far from the sun
   (e) Is very close to the sun
3. The earth has:
   (a) Two poles, namely the north pole and the south pole.
   (b) Four poles, namely east, west, south, and north.
   (c) An axis which is as long as the diameter of the earth at the equator
   (d) An east-west axis.
   (e) Two seasons: cold and wet
4. Spinning of a body on its axis is known as:
   (a) Revolution
   (b) Rotation
   (c) Axis
   (d) Tilt
   (e) Orbit
5. The path used by the earth and other planets when going around the sun is called:
   (a) Revolution
   (b) Rotation
   (c) Orbit
   (d) Axis
   (e) Equinox
6. Seasons of the year are caused by:
   (a) The earth's tilted axis and rotation
   (b) The earth's tilted axis and revolution
   (c) Horizon of the earth
   (d) Solar eclipse
   (e) Lunar eclipse
7. When the moon's shadow is cast over the earth's surface the phenomenon is known as:
   (a) Lunar eclipse
   (b) Solar eclipse
   (c) Equinoxes
   (d) Summer solstice
   (e) Winter solstice

8. Which of the following is evidence that the earth is a spherical?
   (a) The ship comes from far away.
   (b) The ship sails on the surface of a round Earth.
   (c) The ocean water conceals the ship.
   (d) The earth revolves around the sun.
   (e) The ship's visibility in the ocean changes with distance
9. Equal length of day and night when the sun is overhead at the equator is known as:
   (a) Solstice
   (b) Equinox
   (c) Summer
   (d) Aphelion
   (e) Perihelion
10. When the earth's shadow is cast over the moon's surface, the phenomenon is known as:
   (a) Lunar eclipse
   (b) Solar eclipse
   (c) Equinoxes
   (d) Summer solstice
   (e) Day and night

Parallels and meridians

Latitudes or parallels

Latitudes are imaginary lines parallel to the equator joining all the places at an equal angular measurement. The North Pole has a latitude of 90° North and the South Pole has a latitude of 90° South. The equator divides the earth into two equal parts, namely the northern hemisphere and the southern hemisphere (Figure 2.25). The most common parallels are the Equator (0°), the Tropic of Cancer (23½° N), the Tropic of Capricorn (23½° S), the Arctic Circle (66½° N) and the Antarctic Circle (66½°S), and the Horse latitudes (30° N and 30 °S)

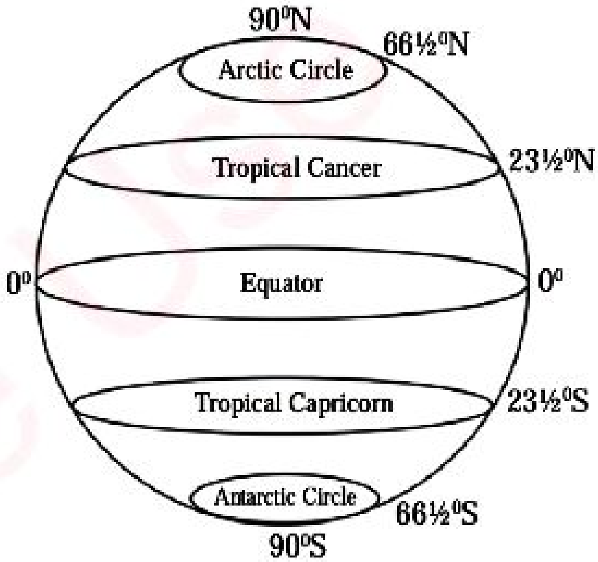


Figure 2.25 Latitudes

Longitudes or meridians

Longitudes or Meridians are imaginary lines which run from the North Pole to the South Pole east or west of the Greenwich meridian (0°). The Greenwich meridian is the prime meridian which passes through the Greenwich Observatory Station near London where it derives its name. In Africa, it passes through Accra in Ghana.

The prime meridian divides the earth into East and West. Since there are 360° in the sphere, meridians of 0° to 180° lie east of the Greenwich meridian and the other 0°

to 180° west of Greenwich. Figure 2.26 shows how the meridians look like from the side of the South Pole or North Pole.

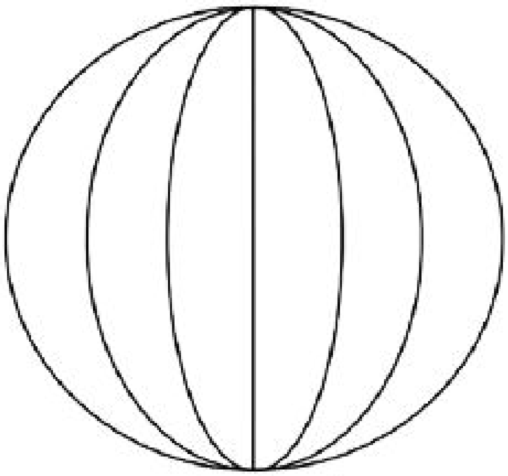


Figure 2.26 Longitudes

Determining latitudes

A latitude is the distance measured in angles of any point north or south of the equator at which a perpendicular line is established from the centre of the earth towards the North Pole or the South Pole (90°). Any angular measurement from the earth's centre to its surface represents a certain latitude (Figure 2.27 (a) and (b)). For example, the tropic of cancer is drawn on the surface of the earth with an angular line of 23½° N measured anticlockwise from the equator. On the earth's surface, 1° of latitude is equal to 111 kilometres. Since the distance from the North Pole to the South Pole is about 20,000 kilometres and there are 180° (half a circle) between them, the distance in kilometres between one latitude and the next must be

$$\frac{20,000}{180} = 111 \text{ km}$$

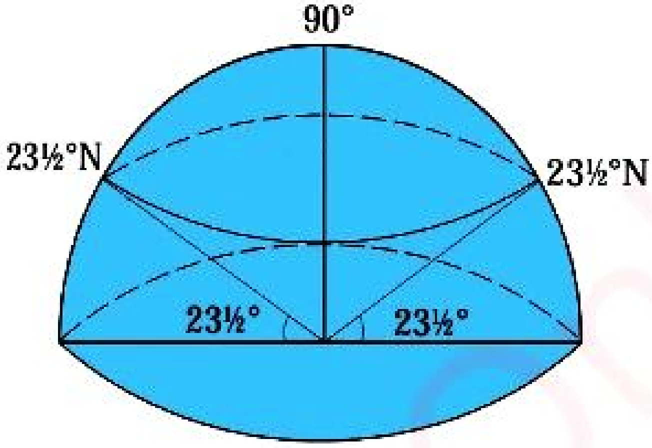


Fig. 2. 27 (a) Determining latitudes

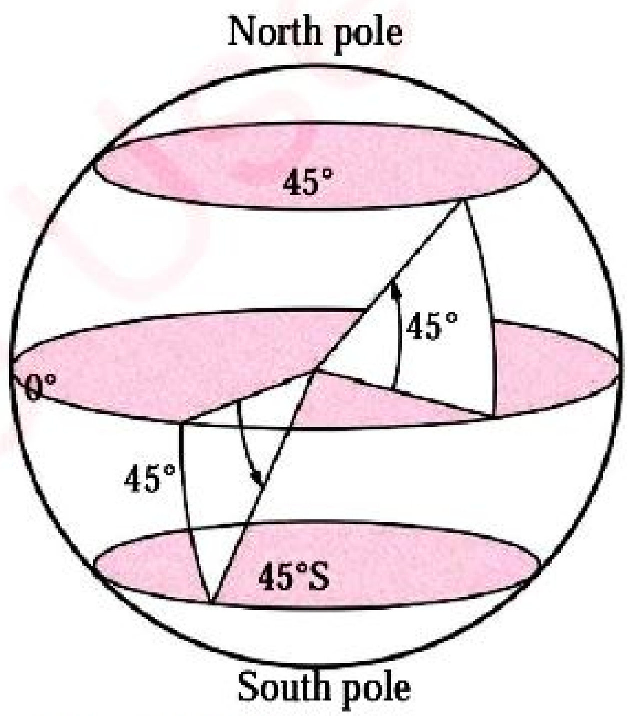


Figure 2.27 (b) Determining latitudes

Determining longitudes

A longitude is the distance measured in angles of any point east or west of the prime meridian. The angle of longitude is determined by measuring the angle from the centre of the earth along the equatorial plane, east or west of the prime meridian. Since the world is about 40,000 kilometres round at the equator and there

360^0 in a circle, the distance between each degree of longitude at the equator must be

$$\frac{40,000}{360} = 111 \text{ kilometres.}$$

Since longitude lines meet at the poles, the distance between degrees of longitudes becomes progressively less towards the poles (Figure 2.28).

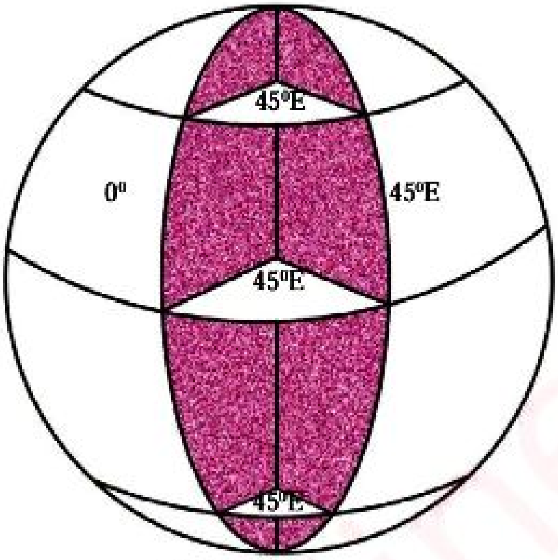


Figure 2.28 Determining longitudes

Activity 2.1

Take a ball and mark two points on it. These points should be opposite to each other. Draw a line at the centre of the two points all around the ball. This line can be called the equator. Note that the line divides the ball into two halves. Since the ball is a sphere, each half of the ball can be called a hemisphere. The point marked at the north can be called a north pole and the one at the south, a south pole. Add more circles parallel to the north and south of the equator. These lines are known as latitudes or parallels. Using the same ball that indicates latitudes, the equator and hemispheres, draw lines that join the two poles indicated on the ball, the north and south. Each line can be called a meridian or longitude. This logic applies to meridians on the spherical Earth.

Great circles

A great circle is any circle that divides the earth into two equal spheres (Figure 2.29). The equator and the Greenwich Meridian together with Meridian 180⁰ are all great circles. Other great circles are the Meridian 10⁰ E and 170⁰ W and 20⁰ E and 160⁰ W. In other words, all the meridians are great circles. The equator, on the other hand, is the only latitude that is a great circle. The number of great circles is limitless.

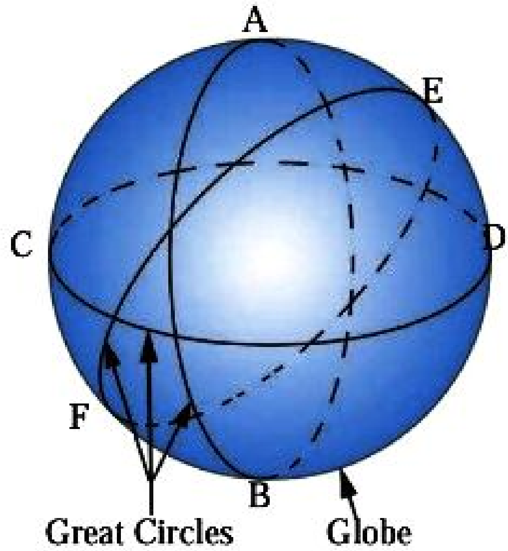


Figure 2.29 Great circles

Importance of great circles

Great circles are used in water navigation (by ships) and aviation (by airplanes). They are used to plot routes for ships crossing the oceans to save fuel and time. In aviation, pilots use great circles to mark the shortest path. In general, great circles are the shortest routes between any two places far apart on the earth's surface.

Importance of latitudes and longitudes

The usefulness of latitudes and longitudes are as follows:

(i) Latitudes determine climatic variations. For example, the temperature decreases from the equator towards the poles.

(ii) Longitudes are used to calculate local time of different places on the earth's surface.

(iii) Longitudes are used to determine days and dates in the world with reference to the International Date Line.

(iv) Both show the location of a place on the earth's surface.

(v) Both help to identify routes for aviation and navigation.

Both help to determine distances between places on the earth's surface.

Calculation of local time using longitudes

The earth rotates on its own axis from west to east once after every twenty-four hours (one day). This means that the earth turns through 360° in 24 hours or 15° in one hour or 1° in 4 minutes. All the places along the same longitude experience mid-day at the same time. For example, if it is 12:00 noon in Addis Ababa (39°E), it will also be 12 noon in Dar es Salaam as it is also located at 39°E. On the contrary, places along different longitudes experience different times. For example, when it is 12 noon at places along the Greenwich meridian (0°), like Accra in Ghana or London in England, it will be 1.00 pm at all places along longitude 15°E or 11:00 am along longtude 15°W. The time recorded along the same longitude is known as Local Mean Time (LMT).

How to calculate local time

Example 1

The local time at Tunis 10° E is 3:00 pm. What is the local time of Mombasa, Kenya 40° E?

Solution

(i) The difference in degrees of longitude between Tunis and Mombasa will be:

$40^{\circ} - 10^{\circ} = 30^{\circ}$

(ii) The difference in time between Tunis and Mombasa will be calculated as follows:

If $15^{\circ} = 1$ hour

Then $30^{\circ} = ?$

So, $\frac{30^{\circ} \times 1 \text{ hour}}{15^{\circ}}$

$= 2$ hours

(iii) Since Mombasa is found in the East of Tunis, Mombasa's time will be ahead of that of Tunis by 2 hours (3.00 pm + 2 hours = 5 pm). Therefore, the time in Mombasa will be 5.00 pm.

Example 2

The local time at Washington, D.C. (96°W) is 05:00 pm. Friday. Find the time and day at Zanzibar (39°E.)

Solution

(i) The difference in degrees between Washington, D.C and Zanzibar will be:

$96^{\circ} + 39^{\circ} = 135^{\circ}$

(ii) The difference in time between Tunis and Mombasa will be calculated as follows:

If 15^{0} = 1 hour

Then 135^{0} = ?

$$= \frac{135^{0} \times 1\text{hour}}{15^{0}}$$

$$= 9 \text{ hours}$$

(iii) Since Zanzibar is to the east of Washington, D.C, time will be ahead of that of Washington, D.C by 9 hours. Thus, 5.00 pm + 9 hours = 02:00 am Saturday. Therefore, the time in Zanzibar will be 02:00 am Saturday.

Calculating the longitude of a place using local time

Example 1

Find the longitudinal position of Mogadishu whose local time is 4:40 pm. when the local time at Tunis 10° E is 2:20 pm.

Solution

(i) The difference in time between Tunis and Mogadishu is given by 4:40 – 2:20 = 2.20 hours.

(ii) Convert the time into minutes.
2 hours 20 minutes = 140 minutes.

(iii) Use the minutes to calculate the difference in degrees of longitude between Tunis and Mogadishu.
Since the earth rotates 1° in 4 minutes, how many degrees will it take to rotate 140 minutes?
Difference in longitude

$$= \frac{140\text{min.} \times 1^{\circ}}{4\text{min.}}$$

$$= 35^{\circ}$$

(iv) Since the time of Tunis is behind that of Mogadishu, then Mogadishu must be located East of Tunis. Therefore, the longitudinal position of Mogadishu will be
10° E + 35° = 45° E.

Example 2

What is the longitude of Lindi whose local time is 8:24 pm when the local time in Montevideo (Uruguay) 56° W is 02:00 pm?

Solution

(i) The difference in time between Lindi and Montevideo will be: 08:24 – 02:00 = 6:24 hours

(ii) Convert the time into minutes 6 hours and 24 minutes = 384 minutes

(iii) Use the minutes to calculate the difference in degrees of longitude between Lindi and Montevideo. The earth rotates 1° in 4 minutes. How many degree will it take to rotate 384 minutes?

Difference in longitude

$$= \frac{384\,\text{min.} \times 1^{\circ}}{4\,\text{min.}}$$

$$= 96^{\circ}$$

(iv) Since the time of Lindi is ahead of that of Montevideo, Lindi must be located east of Montevideo. Therefore, the longitude position of Lindi will be:

$96^{\circ} - 56^{\circ} = 40^{\circ}E$.

Time zones

A time zone refers to a stretch of land where the standard time is accepted throughout the longitudinal zone of 15° in width. There would be problems in telling time if every place had its own time set according to the local mean time.

Essence of time and time zones

The essence of time and time zones resulted from difficulties in identifying time for a particular area. If each place across a country followed its own time, it would create confusion. For example, Dodoma is about $35^{\circ}E$ and Tanga is about $39^{\circ}E$. If each followed its own local time, there would be a difference of 16 minutes between the two towns. There would be confusion in railway and airways timetables or in radio programmes if they had to show different times, each referring to its local area.

To avoid time confusion, different stretches of land take their time from agreed meridians. The time adopted is known as standard time. In East Africa, standard time is taken from the meridian of $45^{\circ}E$. When the whole stretch of land keeps the same standard time and that stretch forms a time zone. The Greenwich Meridian is the starting point for dividing the globe into 24 time zones. The standard time for Greenwich is known as the Greenwich Mean Time (GMT).

Variation of standard time in a single country

Countries with large stretches of land, for example, Russia, the United States of America, Canada and China have several standard time zones for practical purposes (Figure 2.30).

Activity 2.2

Draw a world map and locate the international date line.

Excerise 2.5

A: Circle the letter of the correct statement:

1. (a) The earth rotates around the sun in 364 days.
   (b) The earth rotates on its axis in twenty-four hours.
   (c) The earth revolves around the sun in 364 days.
   (d) The earth revolves around the sun in twenty-four hours.
   (e) The sun rotates around the earth in one year.
2. (a) Days and nights are caused by the rotation of the earth.
   (b) Days and nights are caused by the revolution of the earth.
   (c) Days and nights are caused by the gravity of the sun and the moon.
   (d) Days and nights are caused by the apparent movement of the sun.
   (e) Days and nights are caused by the movement of the moon.
3. (a) A lunar eclipse occurs when the moon passes between the sun and the earth.
   (b) A solar eclipse occurs when the earth casts its shadow on the moon.
   (c) A solar eclipse occurs when the moon casts its shadow on the earth.
   (d) A lunar eclipse occurs when the sun is between the moon and the earth.
   (e) A solar eclipse occurs when the sun casts its shadow on earth

B: Choose and circle the correct answer:

4. What is the time in Bujumbura at 29°E when it is noon in Brazzaville at 14°E?
   (a) 1:00 pm (b) 11:00 am
   (c) 11:00 pm (d) 1:00 am
   (e) 10:00 am
5. What is the approximate difference in meridian time between Mwanza (33°E) and Colombo (80°E)?
   (a) 3:08 hours (b) 4 hours
   (c) 2 hours (d) 5 hours
   (e) 6 hours
6. Which of the following places will experience sunrise earliest on any day?
   (a) Kasese (30°E)
   (b) Tanga (39°E)
   (c) Kitale (35°E
   (d) Iringa (35°E)
   (e) Nakuru (35°E)

C: Complete the following table:

Months	Seasons	
	Northern Hemisphere	Southern Hemisphere
(a) June, July and August	Summer	....
(b) September, October and November	....	....
(c) December, January and February	....	Summer
(d) March, April and May	....	....

D: Answer the following questions:

7. Name the parallels with the following degrees:

   (a) 23½°N (b) 66½°S

   (c) 66½°N (d) 23½°S

8. Name the two most common great circles.

9. Draw an outline of a globe and mark on it the Equator and the Greenwich meridian.

10. It is 4:15 am in a town located at 20°E. Calculate the local time of a town located at:

    (a) 50°E
    (b) 65°E
    (c) 75°E
    (d) 90°E

11. It is 10:00 am along meridian 40°E. Calculate the time along the following meridians:

    (a) 55°W (b) 10°W

    (c) 60°W (d) 0°

12. It is 3:30 pm at the Greenwich Meridian. Calculate the longitude of the following recorded time:

    (a) 5:30 pm (b) 5:30 am
    (c) 12:00 noon (d) 3:45 pm

E: Match each statement from Column A with its corresponding item in Column B:

Column A	Column B
(i) The imaginary line on the earth's surface that divides it into northern hemisphere and southern hemisphere	(a) International Date Line (b) Local mean time (c) The equator
(ii) Determine local time at different places on the earth's surface	(d) Greenwich Meridians and aphelion (e) Parallels and Meridians
(iii) Time recorded along the same longitude	(f) Standard time (g) Time zone
(iv) The line where calendar day begins	(h) Great circles

Chapter Three

Major features of the earth's surface

Introduction

Geography as a discipline deals with the description of both natural and man-made features. In this chapter, you will learn about the continents, major features found on the continents, and water bodies such as oceans, seas and lakes. You will also learn about the major features of the ocean floor.

The earth's surface

The earth is the only known planet that supports life. Its surface is made up of land and water bodies. The earth is surrounded by a layer of gases called the atmosphere. Land occupies about 29 percent of the earth's surface which forms the continents. Water bodies, also called hydrosphere, occupy about 71 percent of the earth's surface.

Land and water bodies interact. This interaction results in the formation of different features. The part of the ocean that penetrates land is called a gulf. Examples of gulfs are the Persian Gulf (Western Asia), The Gulf of Mexico, The Gulf of Bengal and The Gulf of Guinea. The narrow water path that separates landmasses is known as a strait. Examples of straits are the Strait of Gibraltar (Morocco), Luzon Strait (Taiwan) and Makassar Strait (Indonesia).

A piece of land entering the sea or ocean is referred to as a cape. Examples of capes are the Cape of Good Hope in South Africa, Cape Horn in Chile and Cape Leeuwin in Australia. A part of land entering the ocean and sea is called a peninsula. This part is usually surrounded by water for most of its border. Examples of peninsulas are Msasani in Tanzania, Arabian, Alaskan and Indo-China. A narrow land stretch that joins two major land masses is called isthmus. Examples of isthmus include the isthmus of Panama between Nicaragua and Colombia and isthmus of Suez between Africa and Asia.

Continents

A continent is a major landmass rising from the ocean floor. Continents are usually surrounded by a large mass of water bodies such as oceans and seas. Islands adjacent to continents are part of them because they contain the same rock structure. In general, there are seven continents on the earth. These are *Asia*, *Africa*, *South America*, *North America*, *Australia*, *Europe* and *Antarctica* (Figure 3.1). There is more land surface in the northern hemisphere than in the southern hemisphere. With the exception of the continents of Europe and Asia that are separated by the Ural mountains, other continents are separated by oceans and seas.

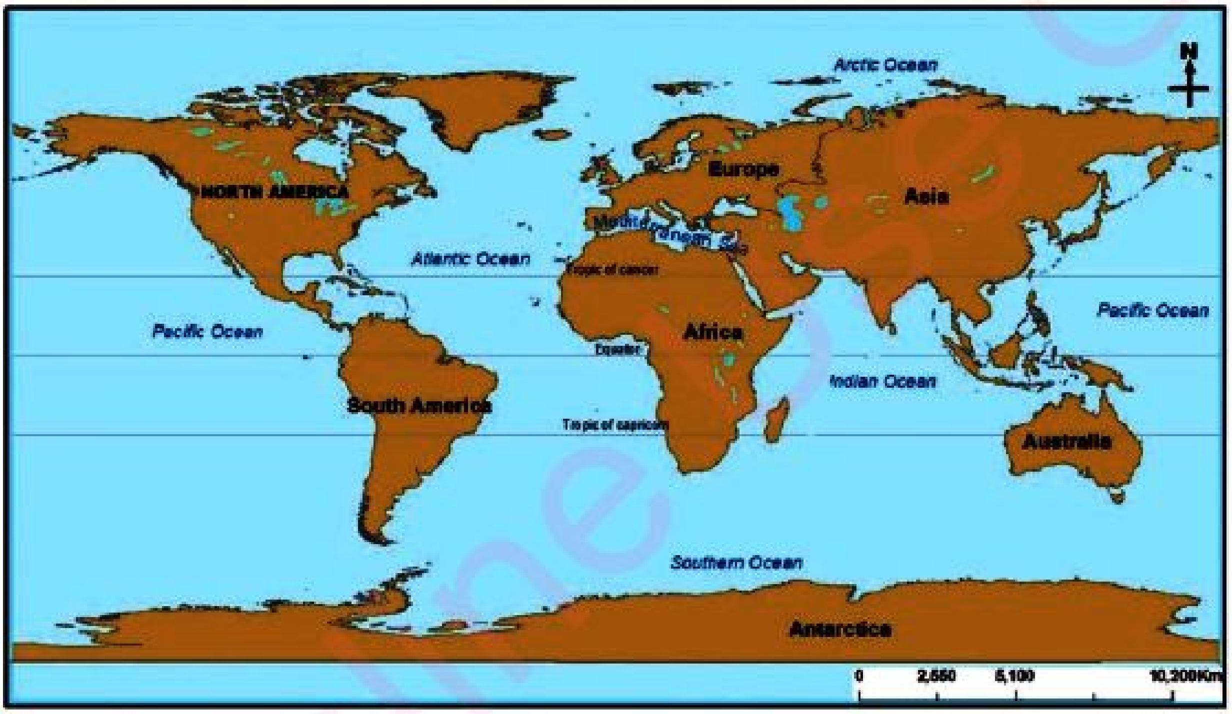


Figure 3.1 Distribution of continents

Asia

Asia is the largest continent. It covers more than one third of the land surface of the earth. It is about one-and-a-half times the size of Africa. Its total area is 44.6 million square kilometres. The continent of Asia stretches from 10° S to 78°N and from 30°E to about 180°E. The continent is bordered to the North by the Arctic Ocean, to the East by the Pacific Ocean and to the South by the Indian Ocean. To the South West, it is bordered by the continent of Africa and is separated by the Red Sea. The Ural mountains form the boundary between Asia and Europe.

Africa

Africa is the second largest continent in size with an area of about 30.3 million square kilometres. Africa extends from 35°S to 37°N and from 15°W to 50°E. About three quarters of the area lies in the tropics. The continent is crossed by the Equator, the Tropic of Cancer and the

Tropic of Capricorn. In fact, Africa is the only continent crossed by both tropics. Africa is bordered by the Mediterranean Sea to the North, the Atlantic Ocean to the West, the Indian Ocean to the East and the Southern Ocean to the South. Islands such as Madagascar, Seychelles, Comoro, Zanzibar, Mafia, Mauritius and the Canaries are part of the continent. The Sahara Desert, the largest hot desert in the world, is found in Africa. Other deserts in Africa include the Kalahari and the Namib deserts.

North America

North America is the third largest continent in size with an area of about 24.7 million square kilometres. It extends from 10°N to 80°N and from 60°W to 160°W. The continent is bordered by the Pacific Ocean to the West, the Atlantic Ocean to the East and by the Arctic Ocean to the North. In the South, it is bordered by the continent of South America.

South America

South America is the fourth largest continent in size about half the size of Africa. Its area is about 17.8 million square kilometres. It lies between 10°N and 50°S and between 35°W and 80°W. The Atlantic Ocean borders this continent to the East and the Pacific Ocean to the West. It is separated from the continent of North America by the Panama Isthmus.

Antarctica

Antarctica is the fifth largest continent in size and it is about one-third the size of Africa. Its area is about 14 million square kilometres. It is situated around the South Pole and almost all of it lies within latitude 66°S. It is surrounded by the Southern Ocean. It is not inhabited by human beings because of the extreme low temperature below freezing point throughout the year. It is in darkness for about six months in a year.

Europe

Europe is the sixth largest continent in size and it is about two-fifth the size of Africa. It has an area of 10.1 million square kilometres. Europe lies between 40°N and the Arctic Circle and between 10°W and 60°E. It lies to the West of Asia. The Ural mountains separate Europe from Asia. To the North, it is bordered by the Arctic Ocean, to the West by the Atlantic Ocean and to the South by the Mediterranean Sea.

Australia

Australia is the smallest continent and it is about a quarter of the size of Africa. It is about 8.5 million square kilometres. Australia lies approximately between 10°S and 40°S and 115°E and 150°E. The islands of New Zealand, which lie Southeast of Australia, are part of this continent. The continent is bordered by the Indian Ocean in the West and in the North by the Pacific Ocean. In the East and South, it is bordered by the Southern Ocean.

Activity 3.1

Draw a world map and on it locate and name the following:

(i) All the seven continents
(ii) Gulfs on each continent

(iii) Capes on each continent

(iv) Peninsulas on each continent

(v) Isthmuses and Straits on each continent

Major features of continents

The surface of any continent is not regular in shape and elevation. The height above the sea level (altitude) and slope (degree of steepness of the land) give rise to different relief features. *Plains, plateaus, mountains* and *basins* form the major relief features of continents. Other features include *hills* and *valleys*.

Plains

Plains are continuous stretches of comparatively flat lands that do not change much in elevation. For example, the Serengeti plains of Tanzania, Siberia in Asia, North European plains, Indo-Gangetic plains in India and the Great Central plains of North America. Many extensive plains result from down warping of the earth's crust. Plains that are found along coastal areas are known as coastal plains. These include the coastal plains of Tanzania, Kenya and Mozambique.

Plateaus

A plateau is an extensive high altitude area with more or less uniform summit level. Plateaus significantly rise above the surrounding area with one or two sides with steep slopes. Plateaus are formed when forces from within the earth uplift a large land area. Uplifted areas of level or undulating land form plateaus, sometimes called tectonic plateaus.

When an uplifted area slopes down to sloping lower land, it is called table land. South African, Arabian and Spanish plateaus are examples of table lands. Some plateaus are formed following successive flow of lava erupting from the interior of the earth resulting in the growth of a lava platform. Such plateaus are known as lava plateaus. Examples include the Deccan plateau in India, Columbia and Snake plateau in the United States of America. Plateaus, which are surrounded by a higher land adjoining mountain, are called intermontane plateaus. Examples of intermontane plateaus are Bolivian plateau that lies between fold mountain ranges of the Andes and Tibetian plateau that lies between Kunlun Shan and the Himalayas.

Mountains

A mountain is part of the earth's surface that rises abruptly to a greater height, usually above 300 metres from the surrounding level. There are four major types of mountains. These are fold mountains, block mountains, volcanic mountains and residual mountains. These mountains are named according to the way they were formed.

(a) Fold mountains

Fold Mountains are mountains formed mainly by the process of folding or wrinkling of the upper parts of the earth's crust due to compressional forces (Figure 3.2 (a)). Major fold mountains in the world include the Himalayas in Asia (Figure 3.2(b)), the Rockies and Appalachians in

North America and the Andes in South America. Others are the Alps in Europe, the Atlas in North Africa and Cape ranges in South Africa.

Figure 3.2(a) A fold mountain

Figure 3.2(b) The Himalaya fold mountains

Source: https://misunriseside.com/interesting-facts-about-himalayas/

(b) Block mountains

A block mountain (horst) is an upland area with a table-like structure bordered by faults on one or both sides. They are formed when tensional or compressional forces in the crust force layers of crustal rocks to break causing the central part to be uplifted (Figure 3.3). Examples of block mountains are the Uluguru, Usambara and Ruwenzori in East Africa, the Vosges and Black Forest Mountains in Europe and Mount Sinai in Asia.

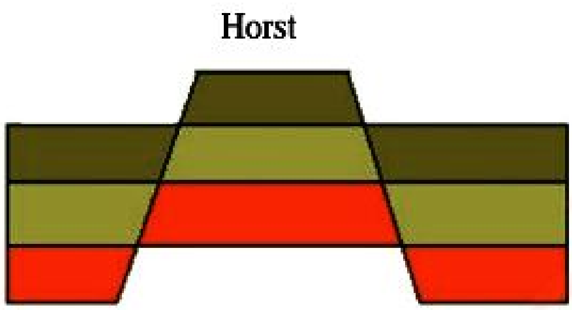


Figure 3.3 A block mountain

(c) Volcanic mountains

Volcanic mountains are cone-shaped mountains formed from the cooling and solidification of hot molten material (lava) from the interior of the earth during a volcanic eruption. There are three main types of volcanic mountains depending on the frequency of eruption.

Active volcanic mountains are mountains that experience periodic eruptions, for example, Oldonyo Lengai in Tanzania, Vesuvius in Italy (3.4a), Nyiragongo in the Democratic Republic of Congo, and Mauna Loa in Hawaii.

Volcanic mountains which erupted only once in historical times and are no longer active are refered to as dormant. Examples include the Kilimanjaro mountain in Tanzania (3.4b), Mount Ararat in Turkey, Fuji and Mauna Kea in Hawaii. Volcanic mountains which have not erupted for a very long time and have not shown any sign of erupting are known as extinct or dead volcanic mountains. Examples include Mount Rungwe in Tanzania, Mount Kulal in Kenya, and Mount Chimborazo in Ecuador.

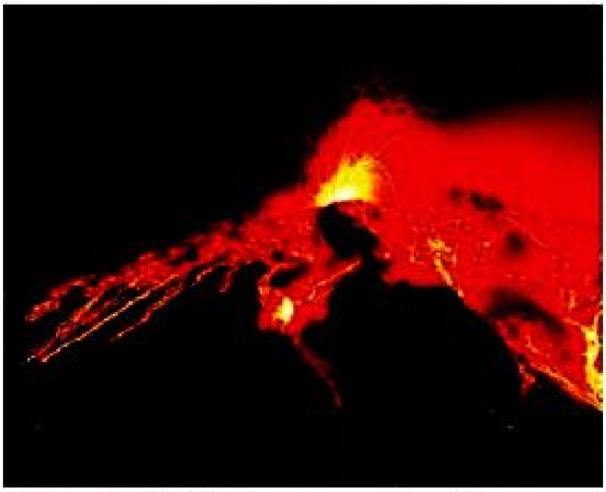


Figure 3.4(a) Volcanic eruption of Mt. Vesuvius in Italy

Source:https://www.hindleygreensacredheart.co.uk/the-nicole-interview-vicious-volcanoes/

Figure 3.4(b) The Kilimanjaro mountain

Source: Kilimanjaro National Park

(d) Residual or denudation mountains

Residual mountains are formed as a result of weathering and erosion of weaker rocks of the already existing mountains leaving behind resistant rocks (Figure 3.5). The remaining resistant rocks are known as residual mountains or mountains of denudation. Examples of residual mountains include the Sekenke Hills of Singida in Tanzania, the Ahaggar Mountains of Central Sahara and the Adamawa Mountains of Eastern Nigeria.

Figure 3.5 A Residual mountain

Source: https://www.google.com search?q=residual +mountains &rlz =1C5CHFA

Rift valleys (Grabens)

A rift valley is a long narrow deep and steep-sided depression between parallel faults on the earth's surface. They are formed through tensional or compressional forces when the ground between two sets of faults sinks (Figure 3.6). The walls of rift valleys form escarpments. An escarpment is an elongated steep slope at the edge of an upland area and gentle slope on the other side.

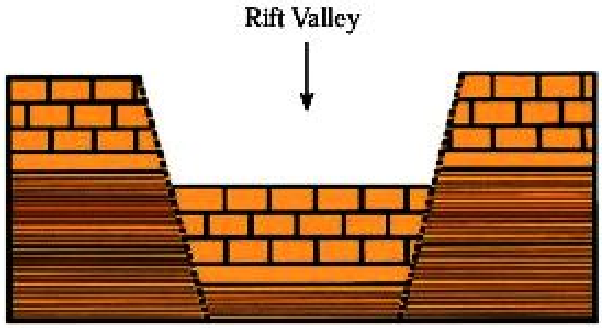


Figure 3.6 A rift valley

The Great African Rift Valley is the longest valley in the world. It stretches from Jordan, through the Red sea, Ethiopia, Kenya and Tanzania to lower Zambezi in Mozambique. In East Africa, the Great African Rift Valley has two arms, namely the eastern and western. The eastern arm is occupied by lakes Turkana, Magadi, Eyasi, Natron and Manyara. The western arm is occupied by lakes Nyasa, Rukwa, Tanganyika, Kivu, Albert and Edward (Figure 3.7). Another rift valley is the Rhine. It is found between the Vosges and Black Forest mountains in Germany.

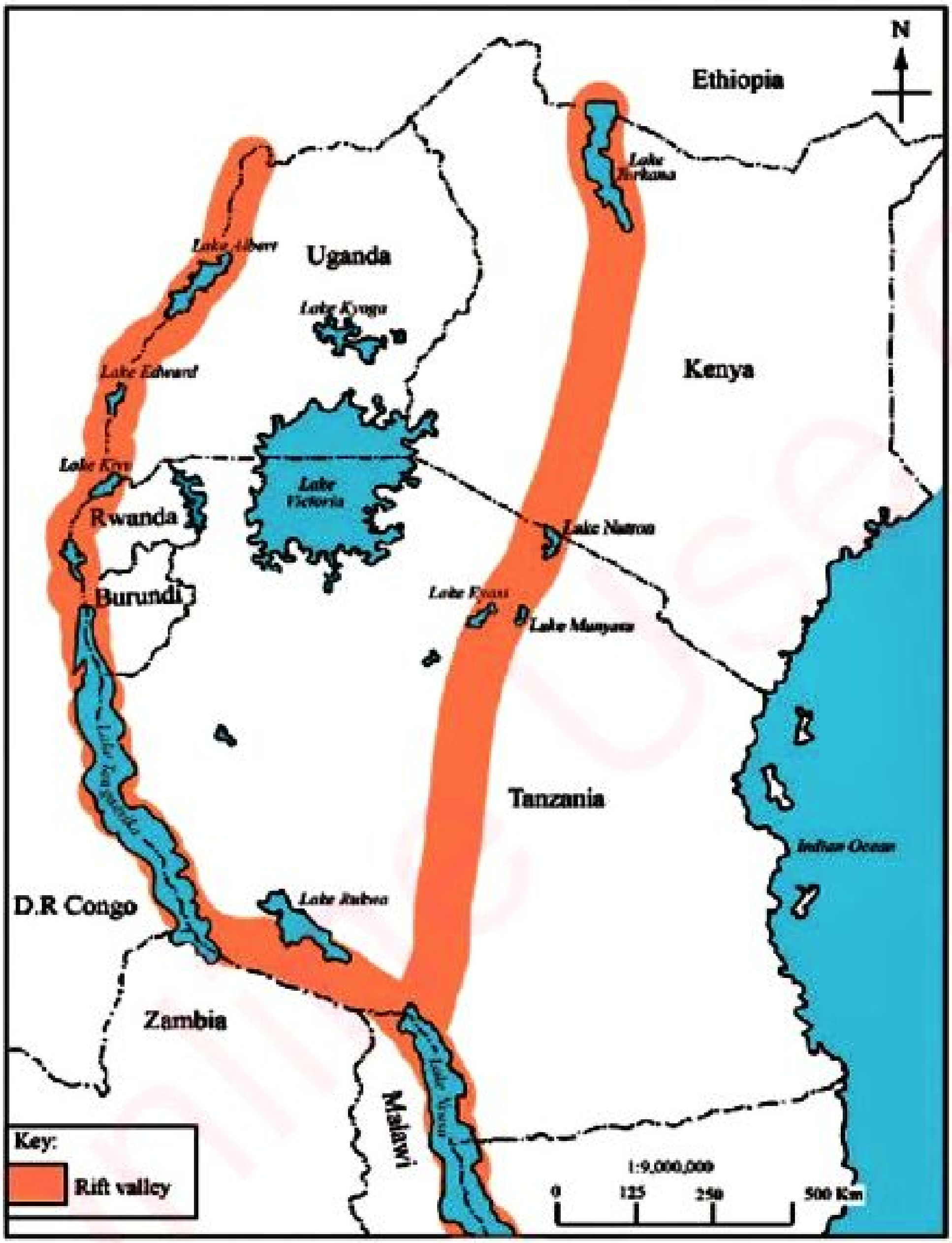


Figure 3.7 The Great African Rift Valley

Basins

A basin is a natural depression or bowl-shaped hollow on the earth's surface, formed when part of the land sinks due to the earth movements. These basins vary in size, with some occupied by water. Basins collect water and sediments from surrounding land surfaces. Some of the basins are found in oceans (ocean basins) or in seas (sea basins) or in lakes (lake basins). Other basins are found higher above sea level and surrounded by mountains. These river basins include the Congo Basin in Africa and the Amazon Basin in South America. Lakes such as Victoria and Kyoga are examples of basins occupied by water. Figure 3.8 shows major relief features of the continents.

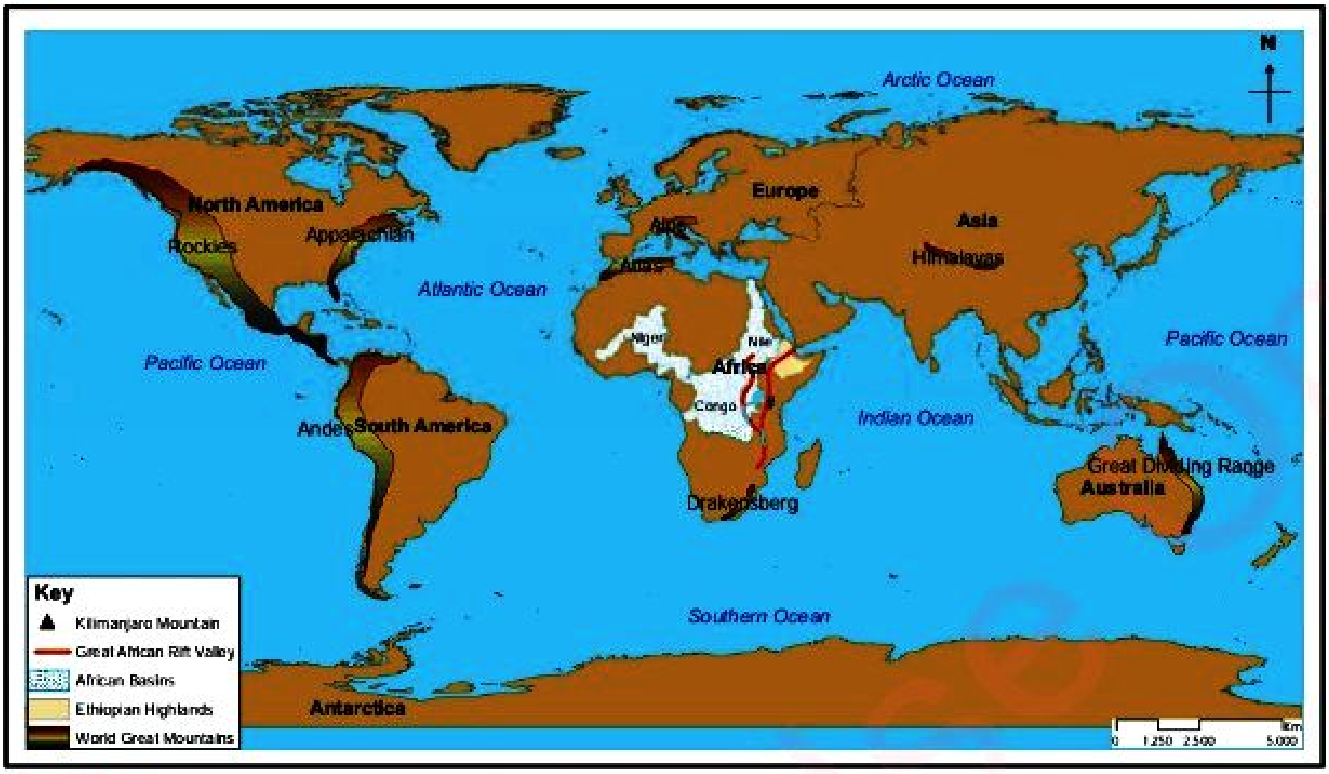


Figure 3.8 Major relief features of the continents.

Water bodies

A water body is an area on the earth's surface where water has accumulated. Water bodies can be salty or fresh, large or small. Water occupies about 71 percent of the earth's surface. There is more water surface in the southern hemisphere than in the northern hemisphere. Some of the major water bodies are *rivers, lakes, seas* and *oceans*.

Rivers

A river is a mass of fresh water flowing by gravity into a definite channel from the source to the mouth. The source of a river may be a watershed, a natural spring, a melting glacier or a marshland. The river's mouth is a point where the river discharges its water into the ocean, sea, lake or swampy area.

In Tanzania, the major rivers are Rufiji, Ruvuma, Kagera, Pangani, Malagarasi, Ruaha, Wami and Ruvu. Major rivers in Africa include the Nile River (6,650 km long), and Congo River (4,700 km long). River Nile originates from Lake Victoria basin and discharges its water into the Mediterranean Sea. Other major rivers in the world are the Amazon River (South America) 6,400 km long, the Mississippi River (North America) 6,275 km long, and Yangtse River (Asia) 6,385 km long.

Lakes

A lake is a hollow or depression in the earth's surface that contains fresh or salty water (Figure 3.9). Example of lakes in Tanzania are Victoria, Tanganyika, Nyasa, Rukwa, Manyara and Eyasi. Some lakes are so large that they are called seas. Examples of such lakes are the Caspian Sea, Dead Sea and the Aral Sea. Although most lakes are permanent, few of them are temporary depending on climatic variations. Some lakes are natural whereas others are man-made, for example, dams.

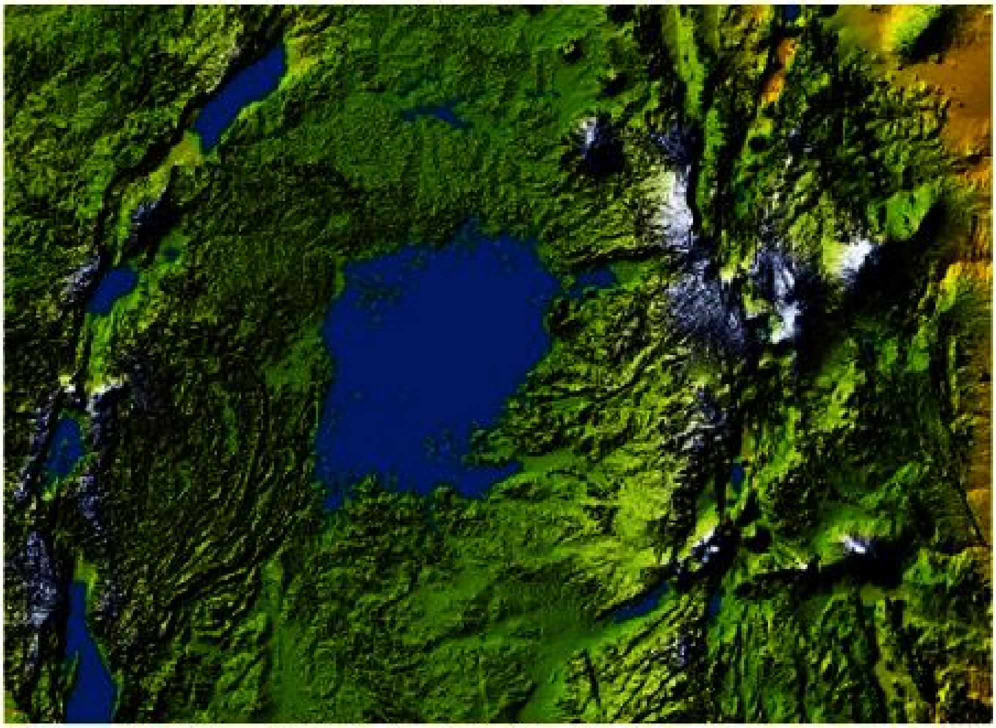


Figure 3.9 Lake Victoria basin in East Africa

Source:http://www.howitworksdaily.com/wp-content/uploads/2011/07/Topography_of_Lake_Victoria_PD.jpg

The Caspian Sea is the largest lake in the World. It is referred to as a sea because of its size and its salty water. Lake Superior in North America is the world's largest fresh water lake followed by Lake Victoria in East Africa. Lake Baikal in Russia (1,642 metres) is the deepest fresh water lake in the world followed by Lake Tanganyika (1,470 metres) found in Tanzania.

Seas

A sea is a large body of salty water that is surrounded in whole or in part by land. Examples include the South China Sea, Sea of Japan, Red Sea, Mediterranean Sea and Yellow Sea. The salinity of a sea depends on the temperature and the amount of fresh water from rivers and melting of ice that is discharged into it. High temperature causes high evaporation that increases the salinity, whereas the addition of fresh water decreases salinity due to dilution. Very high salinity occurs in inland seas such as the Dead Sea because of high evaporation and very little fresh water that enters them.

The Baltic Sea in Europe has a very low salinity because several large rivers discharge into it, evaporation is low, and fresh water is added by melting ice and snow. The seas around the poles, generally have low salinity because of low evaporation and addition of water from melting ice.

Oceans

An ocean is a large body of salty water surrounding the landmass of the earth. The major oceans of the world are the Pacific, the Atlantic, the Indian, the Southern Ocean and the Arctic (Figure 3.10). The oceans of the world with their relative sizes are shown in Table 3.1. The Pacific Ocean is the largest in size whereas the Arctic is the smallest ocean in size.

Table 3.1 Relative sizes of the world's major oceans

SN	Ocean	Size (Million Km²)
1	Pacific Ocean	168.7
2	Atlantic Ocean	85.1
3	Indian Ocean	70.5
4	Southern Ocean	22.0
5	Arctic Ocean	15.6

where the continental shelf forms a steep slope towards the ocean basin.

(iii) **Mid-ocean ridge**

A mid-ocean ridge is a raised part of the ocean floor. Some of these ridges appear above the surface of the ocean as oceanic islands. Examples of the mid-oceanic ridges are the Mid-Atlantic Ridge in the Atlantic Ocean and the Mid-Indian Ridge in the Indian Ocean.

(iv) **Deep sea plain (Abyssal plain)**

Deep sea plains are extensive undulating areas of the ocean floor. Large parts of these plains are covered with thin layers of sediments of both organic and inorganic materials.

(vi) **Abyssal hill**

Are small sharp hills raising from abyssal plain surface.

(v) **Ocean deep or trench**

An ocean deep or trench is a long narrow steep sided depression plunging from the deep sea plain to the depths of 10,000 metres or more. The deepest known ocean trench in the world is Mariana Trench (10,994 metres) of the Island of Guam in the Pacific Ocean.

(vii) **Islands**

An island is a piece of land surrounded by water. Islands may occur in oceans, seas, lakes or rivers. A group of islands is called archipelago. Examples of archipelago include Islands of Zanzibar and the Comoros. There are three types of islands: continental islands, oceanic islands and coral islands.

(a) **Continental islands**

A continental island is a large unbroken landmass similar to a continental landmass rising from a continental shelf. Examples of continental islands include Mafia, Pemba and Unguja, Philippines, Indonesian, Greenland and Sri Lanka.

(b) **Oceanic islands**

Oceanic Islands rise direct from the ocean floor. Some of the oceanic islands are the tops of oceanic ridges, plateaus and ocean floor volcanoes. Examples of oceanic islands are Hawaii, Cape Verde, Iceland, Canary and Seychelles.

(c) **Coral islands**

A coral island is an island, which is built up from a limestone rock made of skeletons of very small marine organisms called coral polyps. Examples of coral islands are the Maldives, Al dabara, Bermuda and St. Martines Islands.

Activity 3.2

Obtain a physical map of the world and:

(a) Identify and locate the major water bodies.

(b) Identify the countries through which the river Nile, the Congo and the Amazon rivers drain their waters.

Exercise 3

A: For each of the item (i) to (x) choose and circle the most correct answer from the options given:

1. Which one among the following is an example of a major fold mountain in the world?
   (a) The Himalayas in Asia
   (b) Ruwenzori in East Africa
   (c) Vosges and Black Forest in Europe
   (d) Sekenke in Tanzania
   (e) Kilimanjaro in Tanzania

2. From the following pairs of mountains, which one represent block mountains:
   (a) Himalaya and Vosges
   (b) Alps and Usambara
   (c) Alps and Andes
   (d) Uluguru and Usambara
   (e) Kilimanjaro and Vesuvius

3. Which of the following is a an example of residual mountains?
   (a) Sekenke hills in Singida
   (b) Kibo in Kilimanjaro
   (c) Uluguru in Morogoro
   (d) Usambara in Tanga
   (e) Meru in Arusha

4. Dormant volcanic mountains are those which:
   (a) Have never experienced eruptions
   (b) Have erupted once but are no longer active
   (c) continue to erupt occasionally
   (d) erupt only when there is an earthquake
   (e) erupt every year

5. Fold mountains are formed by:
   (a) Faulting of the mountain
   (b) Outflow and spread of lava over the land
   (c) Wrinkling of the layers of the earth's crust
   (d) Sinking of the earth's crust
   (e) Prolonged erosion

B: Answers the following qestions:

1. List the continents of the earth and indicate the size of each.
2. Differentiate between the following terms:
   (a) Lakes and Rivers
   (b) Plains and plateaus
   (c) Continental shelf and continental slope
3. Give two examples of residual mountains.
4. Give three examples of fold mountains in the world.
5. Explain why continental shelves are suitable grounds for fishing.

C: Read carefully the following statements and write T for a TRUE statement and F for a FALSE statement:

1. The Antarctica is the warmest continent on earth.

2. Ocean ridges and residual mountains are features of the ocean floor.
3. Ocean floors have relief features such as plains, ridges, slopes and basins.
4. The Kilimanjaro Mountain is an example of an extinct volcano.
5. Block mountains are also known as residual mountains.
6. The ocean water is equally distributed between the northern and southern hemispheres.
7. The formation of residual mountains is associated with the erosion process.
8. The Great African Rift Valley is the longest valley in the world.
9. Zanzibar and the Comoros are archipelagos.
10. Sea water is saline in nature.

D. Match the description of land mass given in Column A with its corresponding responses in Column B.

Column A	Column B
(i) Plains, plateaus, mountains, basins and valleys	a. Gulf
(ii) A continent not inhabited by humans	b. Asia
(iii) Water inlets to the land	c. Straits
(iv) Good Hope, Horn and Leeuwin	d. South America
(v) A major landmass rising from the ocean floor	e. Capes
(vi) A tract of land entering into a body of water	f. Peninsula
(vii) Narrow water paths that separate landmasses	g. Continent
(viii) The boundary between one drainage and the next	h. Relief features
(ix) A continent bordered by the Pacific ocean in the west and Atlantic ocean in the east	i. Antarctica
(x) A continent that covers more than one third of the earth	j. Australia
	k. Africa
	l. Watershed

Chapter

Four

Weather and climate

Introduction

When we say it is hot or cold, sunny or cloudy, windy or calm, we refer to the weather condition. The description of the condition of a place as hot and wet, or dry and cool, intends to describe the climate of that area. The two concepts are interrelated since prolonged weather patterns of a place lead to climatic conditions. In this chapter, you will learn about the meaning of weather, elements of weather and how to establish a weather station. You will also learn about the instruments used to measure elements of weather, and weather forecasting. Furthermore, you will learn about climate, weather and climate, and types of climate and their relationship with human activities.

Meaning of weather

Weather is a condition of the *atmosphere*, which occurs at a particular place and time from hour to hour or day to day. It is usually recorded for a short period of time. The atmosphere is the layer of gases (air) surrounding the earth. A weather condition involves a state of the *elements of weather* such as *temperature, sunshine, cloud cover, precipitation, humidity, atmospheric pressure* and *wind*. People describe the weather of a place as good or bad depending on the state of the atmosphere at that particular time.

Importance of weather

Weather is an important aspect in our environment. It affects our daily activities in one way or another. The following statements explain why weather is important to us:

(a) Rainfall as an element of weather, determines the distribution of economic activities such as crop cultivation and livestock keeping. Lack of rainfall can lead to severe shortage of food and water for both humans and animals.

(b) Ability to predict weather enables planning for various human activities such as air, surface and water transport, crop cultivation, livestock-keeping and sports (surfing, canoeing, boat racing, football and netball).

(c) Weather influences the type of clothes people wear and the type of houses people build. For example, during the hot season people wear light clothes and during cold weather people wear heavy clothes.

(d) Weather and climatic conditions influence the migration and distribution of people and animals. For example, pastoral communities in East Africa often move with their livestock from one area to another depending on the availability of pasture and water. Seasonal rains trigger the onset of wildebeest migration in the Serengeti National Park in Tanzania, and the Maasai Mara Reserve in Kenya.

(e) Weather through wind enables pollination of plants. Pollination is the process of transferring the pollen grain from an individual plant to another or within the same plant. When wind blows can transfer pollen grain from one plant to another or within the same plant. In so doing the plant achieve fertilisation.

(f) Weather influences the process of soil formation through breaking down of rocks, erosion, deposition and decomposition.

Relationship between weather and human activities

Weather affects human activities in different ways. For example, when there is heavy rainfall, floods are likely to occur. Floods destroy crops, cause deaths of human beings and livestock, and damage infrastructure. In addition, drought conditions affect food production which may result in hunger and malnutrition. In some areas, human activities are limited to indoors. For instance, drying of crops is carried out indoors when weather is not favourable. Storms and hurricanes caused by severe weather prevent human activities in oceans and seas, including navigation and fishing. Hailstone and frost destroy crops and lead to low harvest. Furthermore, changes in weather (e.g. temperature) may lead to migration of wildlife such as wildebeest, birds and fish, thus affecting tourism activities.

Exercise 4.1

1. Define weather.
2. Describe the weather of the previous day.
3. Explain the way weather conditions may encourage or discourage the following:
   (a) Types of clothes people wear.
   (b) Drying of grain and fish.
   (c) Out-door games such as football.
   (d) Working in the fields such as tilling the land, planting and harvesting.

Elements of weather

The weather of a place is based on the conditions of several elements. These elements are *sunshine, temperature, humidity, precipitation, wind, atmospheric pressure* and *cloud cover.*

Sunshine

Sunshine is the light we get from sun rays. There is less light on earth when there are clouds in the sky. The type of clouds in the sky determines the amount and duration of sunshine. When there are no clouds, the intensity of sunshine is high. Sunshine also affects other elements of weather such as temperature, humidity, atmospheric pressure, and wind speed and direction. Sunshine is important as follows:

(i) It provides heat for drying clothes and crops.

(ii) Morning sunshine is a source of Vitamin D, which is necessary for human health.

(iii) It is used to generate electricity (called solar power).

(iv) Plants use sun-light in making food through the process known as *photosynthesis*.

(v) It facilitates rain formation through evaporation and transpiration.

Temperature

Temperature is the degree of hotness or coldness of a body or place. It is measured using a thermometer and is expressed in degree centigrade (°C) or degree Fahrenheit (°F) scale. The temperature of a place changes over time. For example, sunny and cloudless days experience high temperatures whereas at nights the temperature is low. On a weather map, temperature is shown by lines joining all places with equal amount of temperature. These lines are known as *Isotherms.*

Factors affecting temperature

Factors that affect temperature include *altitude, ocean currents, distance from the sea, latitude, cloud cover, aspect, length of day* and *winds.*

(i) Altitude

Altitude is the height above the sea level. Temperature decreases with increasing altitude at the rate of 0.6 °C for every 100 metres. The decrease in temperature with increasing altitude is called *lapse rate.* Similarly, temperature increases at the same rate with decreasing altitude (Figure 4.1). The effect of altitude on temperature is well noted in areas of high altitude in Tanzania. For example, the summit of Mount Kilimanjaro which rises to 5,895 metres above sea level is permanently covered with snow for the same reason.

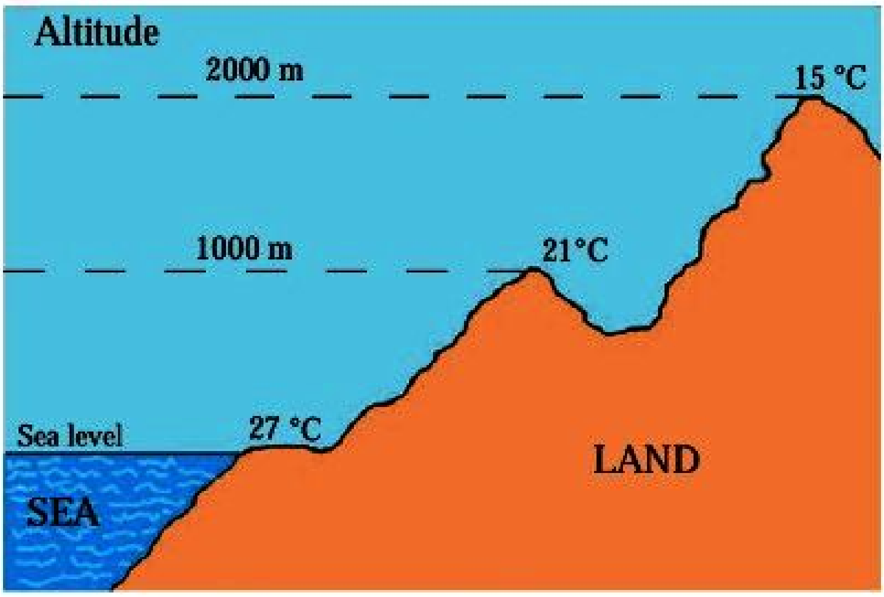


Figure 4.1 Temperature differences in relation to altitude

Calculation of temperature of a place in relation to altitude

Two distinctive geographical areas can vary in temperature in relation to altitude. For example, if the temperature of Bagamoyo at 100 m above sea level is 29 °C, what will be the temperature of Arusha 3,600 m above sea level?

Procedures:

(i) Find the difference in altitude between Bagamoyo and Arusha.

The difference in altitude between Bagamoyo and Arusha is:

3,600 m - 100 m = 3,500 m.

(ii) Calculate the difference in temperature between Bagamoyo and Arusha
If 0.6 °C of temperature decreases with altitude of 100 m, then

$$= \frac{3500\text{ m}}{100\text{ m}} \times 0.6\,^{\circ}\text{C}$$

$$= 35 \times 0.6\,^{\circ}\text{C}$$

$$= 21\,^{\circ}\text{C}$$

(iii) Find the temperature of Arusha.

Since Arusha is at a higher altitude than Bagamoyo, the temperature of Arusha will be lower than the temperature of Bagamoyo.

Thus 29 °C– 21 °C= 8 °C

Therefore, the temperature of Arusha will be 8 °C

(ii) Ocean currents

An ocean current is the horizontal movement of ocean water. Ocean currents are either *warm* or *cold.* A warm current raises the temperature of winds blowing over them whereas cold currents lower temperatures of such winds. Therefore, coastal areas lying near warm currents tend to have higher temperatures than those near cold currents, which tend to have lower temperatures. Examples of ocean currents include the cold currents of Benguela, Peru, Canaries, Oyashio and Western Australia, and warm currents of Mozambique, Brazil, Kuroshio, Gulf Stream and Eastern Australia.

(iii) Distance from the sea

Land surface warms and cools much more quickly than the sea surface. These differences in warming and cooling capacity have a marked influence on temperature. The difference can best be observed in higher latitudes with temperate climates. In these regions, coastal areas are usually warmer during the Winter season due to warm air from the sea. On the other hand, distant (continental) areas from the sea are cooler because they lose temperature faster than the sea.

(iv) Latitude

The amount of heat received at any place depends on the angle at which the sun rays strike the surface of the earth and the duration of sunshine. At the equator, the sun rays reach the earth's surface at almost right angles throughout the year, but the angle decreases as one moves towards the poles. Therefore, temperatures decrease with increase in latitude because the sun rays spread over a larger area causing its heating effect to decrease (Figure 4.2).

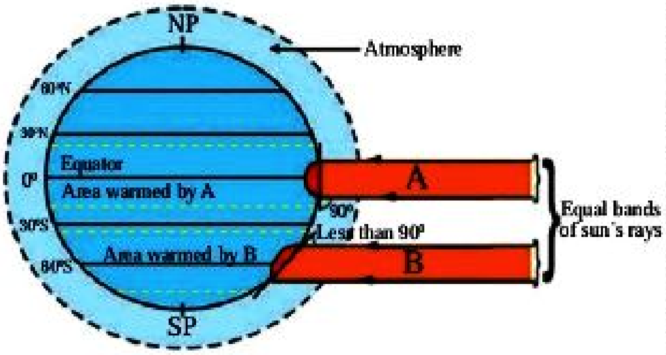


Figure 4.2 Effects of latitude on temperature

(v) Wind

Winds blows from areas of high pressure to areas of low pressure. Cold areas have high pressure whereas warm areas have low pressure. Winds blowing from cold areas have a tendency of lowering the temperature of warmer areas. For example, during summer, temperature over the land is high whereas that of over the ocean is low. Winds blowing from the ocean will lower the temperature over the land.

(vi) Cloud cover

Cloud cover reduces the amount of solar radiation reaching the earth's surface and the amount of earth radiation leaving the earth's surface. In so doing, the temperature of an area with heavy cloud cover such as the equatorial region remains relatively constant. In areas with no or less cloud cover such as deserts the diurnal (daily) range of temperature is large. A cloudless sky allows for maximum solar radiation and out-going earth radiation compared to a cloudy sky.

(vii) Aspect

Aspect refers to the direction of a slope. In higher latitudes in the northern hemisphere, south-facing slopes are warmer than north facing slopes because they receive more sun rays. In the southern hemisphere, north-facing slopes are warmer than south facing slopes for the same reason.

(viii) Length of the day time

Longer days have more time to absorb solar energy than shorter days. Areas with longer day time are warmer than those with shorter day time because of differences in the duration of solar radiation.

Importance of temperature

The temperature of a place at any given time is important in the following ways:

(i) It determines clothing, food and human activities of a place. For example, clothing at times of low (cold) temperature differs from the one that arises during times of high (warm) temperatures.

(ii) It determines the germination of seeds and growth of plants because different plants require different temperatures for their growth.

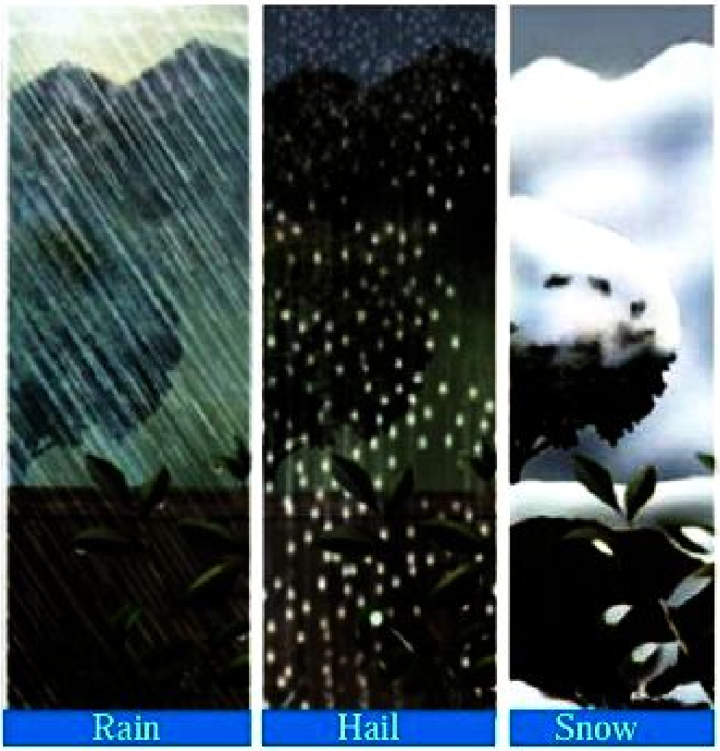


Figure 4.3 Precipitation

Source: https://civilengineersforum.com/9-types-of-precipitation/

Snow

Snow is frozen water in crystals. Snow is formed when water vapour in the atmosphere turns into crystals of ice and reaches the ground before melting.

Hail

Hail is a form of falling solid precipitation with small balls or irregular lumps of ice. This type of precipitation can cause considerable damage to plants and property.

Sleet

Sleet is a mixture of snow and rain. It is formed when the temperature of the ground is lower than the temperature above.

Rainfall

Rain is the most common form of precipitation. Rainfall refers to droplets of water falling from the atmosphere after *condensation*. Condensation is the process by which water vapour in the atmosphere is changed into liquid. When water vapour rises, it cools at high altitude until *dew point* is reached. Dew point is the temperature at which the atmosphere is saturated with water vapour.

Condensation takes place to form clouds after dew point has been reached. Moist air contains minute particles of matter called *nuclei* that are made of dust, salt, ice and soot. Large water droplets join the nuclei to form *raindrops*. When rain drops continue to grow, they are unable to stay in the atmosphere, hence they fall to the ground as rain (Figure 4.4).

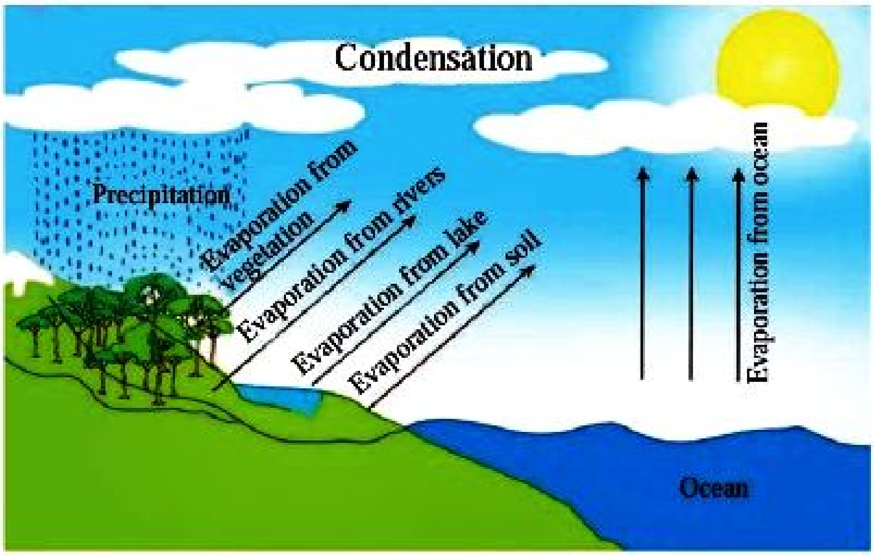


Figure 4.4 Rainfall formation

Types of rainfall

There are three main types of rainfall. These are **convectional, relief** and **cyclonic** rainfall.

(i) Convectional rainfall

Convectional rainfall is formed as a result of differential heating of the earth's surface that causes warm moist air currents to rise. As the air current rises vertically to higher altitudes, it cools and condenses to form clouds from which rain falls (Figure 4.5). The convectional rainfall is common in tropical areas.

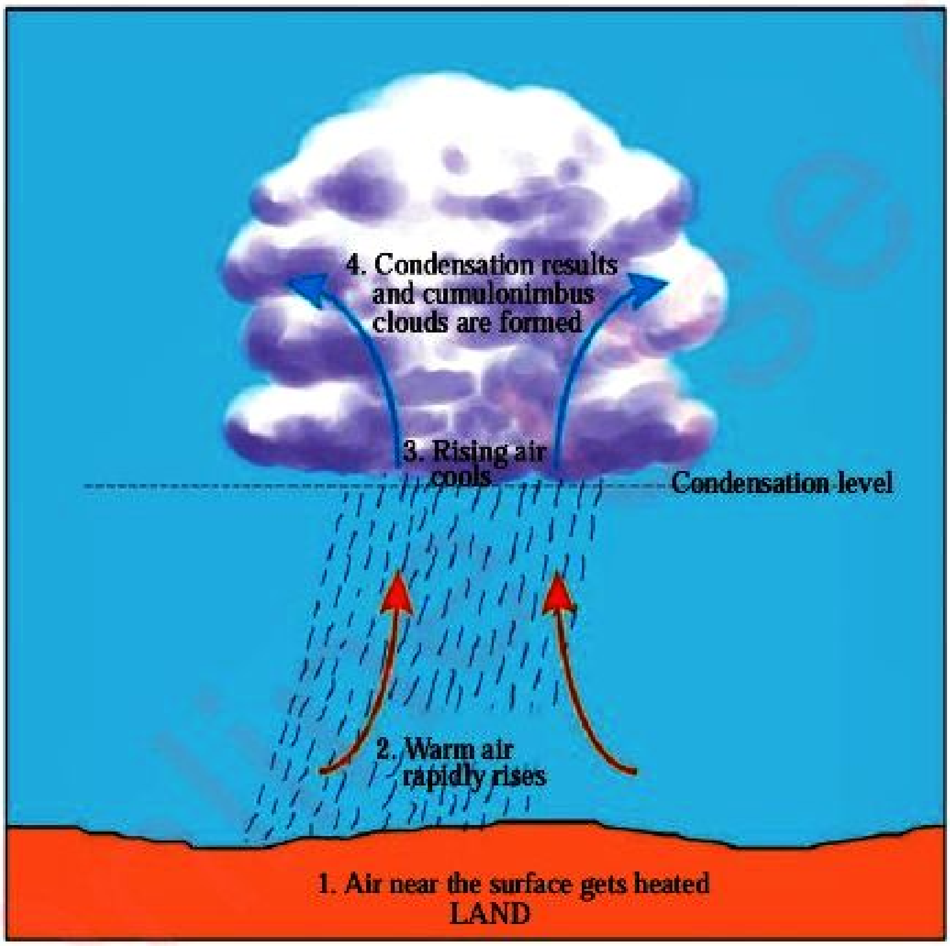


Figure 4.5 Convectional rainfall

(ii) Relief or orographic rainfall

Sometimes moist winds from the ocean are forced to rise over a high mountain. When they reach higher altitudes, the moisture in the wind condenses to form clouds that form droplets which eventually fall as rain. Rain formed this way is called relief or orographic rainfall (Figure 4.6). The side of the mountain facing the direction of the wind is known as a *windward* side. This side receives more rainfall. The side which faces away from the direction of the wind is known as a *leeward* side or a rain shadow area. The leeward side gets very little or no rain because the descending winds from windward side are already dry and cannot form rain.

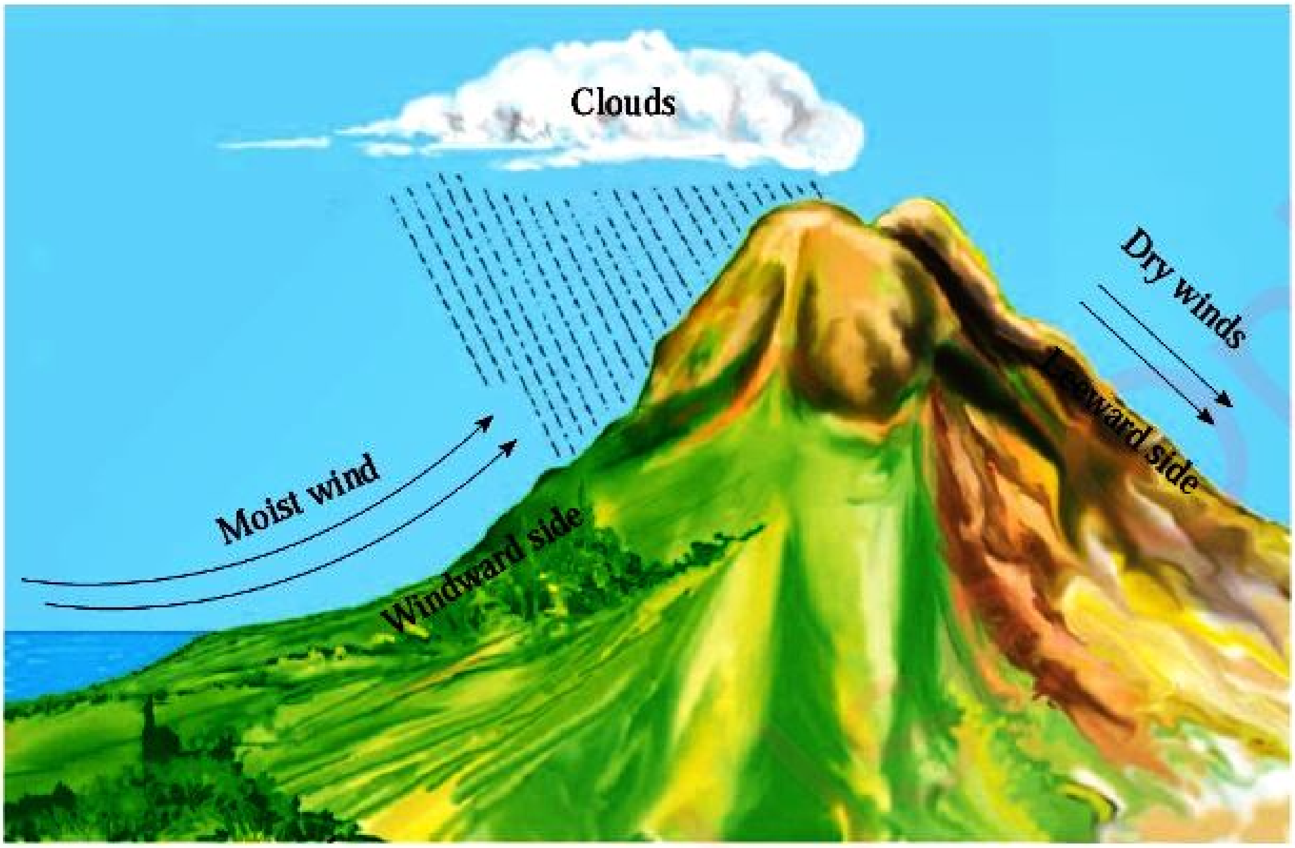


Figure 4.6 Relief rainfall

A typical example of a rain shadow in Tanzania is found on the western side of mount Kilimanjaro. Winds blowing from the Indian Ocean in the East are forced by this mountain to rise and drop most of their moisture as rain on the eastern and south-eastern slopes. When these winds reach the western side of the mountain, they are already relatively dry, so little rain falls on this side. Other examples in Tanzania include the western sides of Usambara and Pare mountains.

(iii) Cyclonic or frontal rainfall

Cyclonic rainfall is also known as *frontal* rainfall. When a large mass of warm and moist air meets a mass of cool and dry air, rain may occur. The warm, light and moist air is forced up over the cool and dry air. At higher altitudes, the warm air cools and water vapour condenses to form clouds and eventually rain (Figure 4.7). Rainfall formed in this way is called cyclonic rainfall.

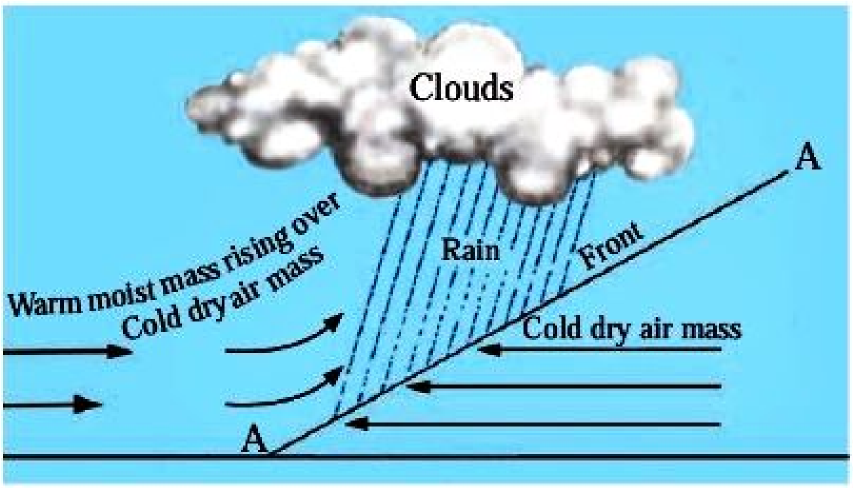


Figure 4.7 Cyclonic rainfall

Factors affecting rainfall

Rainfall variation is a normal phenomenon on the earth's surface, which is influenced by a number of factors. These factors include *ocean currents, distance from the equator, prevailing winds, presence of water bodies, nature and shape of the coast, distance from the sea, altitude, human activities* and *forest cover*.

(i) Ocean currents

There are two types of ocean currents: *warm* and the *cold ocean* currents. Warm ocean currents cause rainfall over the adjacent land because the winds that cross over them carry large amounts of moisture. For example, the warm Mozambique ocean currents cause rainfall along the East coast of Southern Africa.

Since cold ocean currents absorb moisture from the wind over them, the winds that blow over them carry very little moisture. Hence, they bring very little or no rain to the adjacent land. Fog is formed instead of rain. For example, the Cold Benguela Ocean Currents on the south-western coast of Africa and the Canaries Currents on the north-western coast of Africa cause the adjacent land to be dry (Figure 4.8).

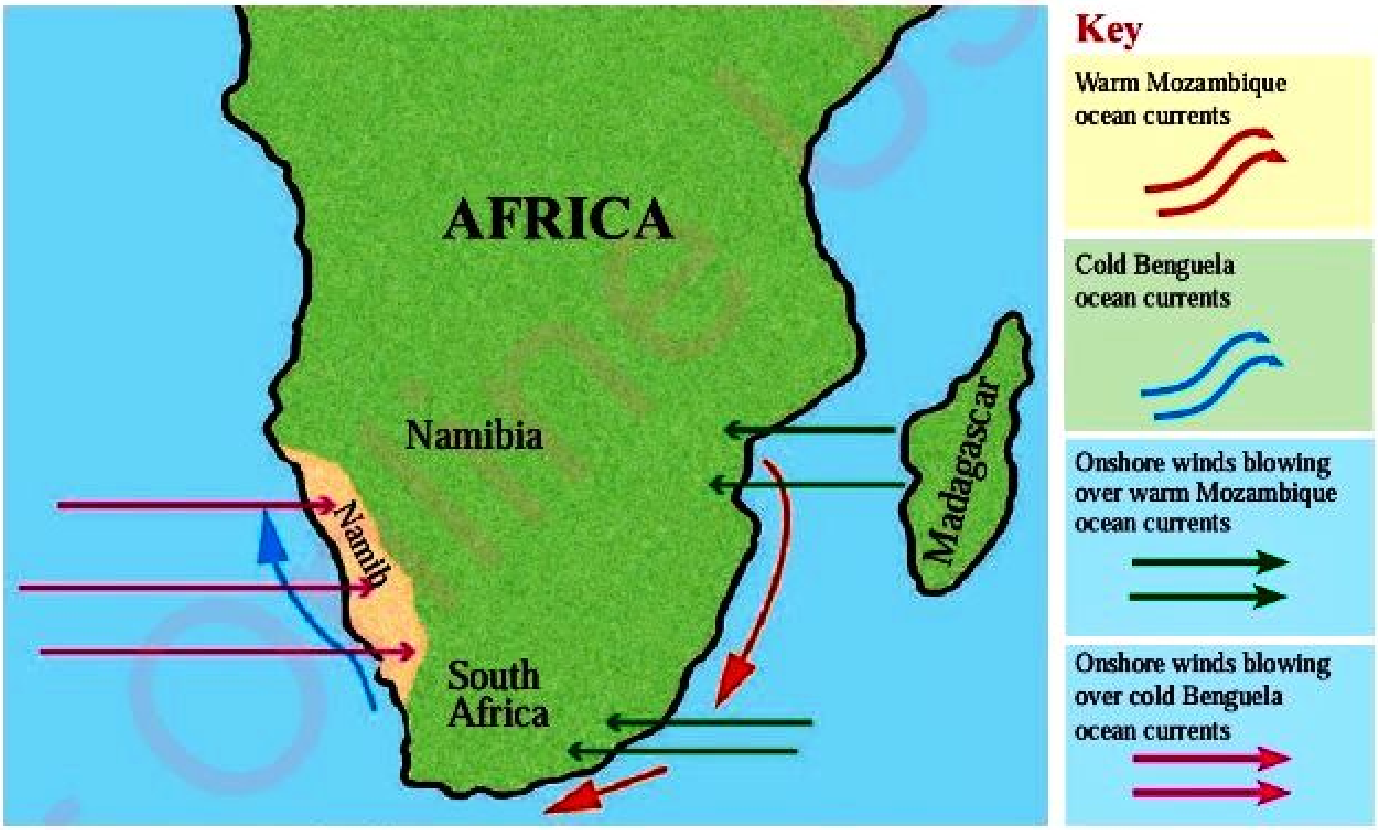


Figure 4.8 Warm and cold ocean currents

(ii) Distance from the equator

Areas along the equator receive more rain than areas away from it. This is because of the high amount of solar radiation, which causes high evaporation and rising of moist air. When air condenses, it results in convectional rainfall. The Congo and Amazon basins are few examples of areas that receive much rainfall due to their being positioned near the equator.

(iii) Prevailing winds

Winds blowing across large water bodies such as oceans, seas and large lakes to the land carry moist air. These moist winds cause rainfall on the land adjacent to the respective water bodies. On the contrary, winds blowing from the land towards the sea carry little or no moisture causing little or no rainfall along the coast.

(iv) Presence of water bodies

Areas with large water bodies such as those around Lake Victoria receive more rain than areas without water bodies such as Dodoma or Singida in central Tanzania. Water bodies increase moisture content in the air passing over them, hence causing rain in nearby areas over which they blow.

(v) Nature and shape of the coast

Coastal areas that lie parallel to rainfall-bearing prevailing winds receive little or no rainfall. For example, the north-eastern coast of Kenya experiences dry weather conditions because it lies parallel to the rain bearing winds called the North East Trade Winds.

(vi) Distance from the sea

Areas located near the sea or ocean experience high rainfall due to winds carrying moisture from the sea to the land, which causes rainfall to the coastal areas. Areas that are very far from the sea receive little or no rainfall because the onshore winds lose their moisture as they travel to the interior. For example, Dar es Salaam in Tanzania receives more rains than Dodoma and Singida, which are far away from the Ocean.

(vii) Altitude

Altitude is a factor for uneven distribution of rainfall. Highlands force the warm and moist air to rise over them, which later condenses to form clouds and eventually rainfall. At higher altitudes, there are low temperatures that allow rising warm and moist air to condense unlike lower altitudes. As a result, higher altitudes receive more rainfall than lower altitude areas. Examples of such areas include the slopes of Mount Kilimajaro and Mount Rungwe in Tanzania.

(viii) Human activities

Human activities such as agriculture, manufacturing, lumbering and development of settlements cause rainfall variations on the earth surface. Human activities that involve removal of the vegetation cover on the earth's surface reduce the surface area for evaporation and transpiration, hence affecting the process of rainfall formation. When the process of evaporation, condensation and precipitation are interrupted, little or no rainfall is formed.

(ix) Forest cover

Trees in the forest absorb moisture through their roots. The moisture absorbed later on tends to evaporate through pores (stomata) in their leaves. This leads to the release of moisture (water vapour) in the atmosphere. When the water vapour in the atmosphere condenses, it falls as rain, hail or snow. The area with no forest cover will receive little amount of rain compared to areas with forest cover. Forest may contribute 90 percent of the moisture in the atmosphere derived from the land surface.

The importance of precipitation

Precipitation is important to human life and the environment because it:

(i) Facilitates the functioning of the hydrological cycle.

(ii) Helps agricultural activities in most developing countries.

(iii) Provides water for domestic and industrial use.

(iv) Creates scenery for sports and recreation activities such as skiing and ice-skating.

(v) Leads to the formation of water bodies such as lakes, rivers, dams and swamps.

(vi) Provides a resource for the generation of electricity (hydroelectric power).

(vii) Facilitate soil formation

Precipitation can have negative effects as follows:

(i) It may leads to loss of life and property such as houses, roads and bridges due to floods.

(ii) It may damages crops due to the effect of hailstones and storms.

(iii) It increases property maintenance costs through repairs and reconstruction after damages caused by precipitation e.g. snow ploughing on roads, railways, airports and bursting of dams.

(iv) It may lead to the outbreak of water-borne diseases such as cholera, typhoid, dysentery, bilharzia and diarrhoea.

Wind

Wind is the air in motion that blows from the area of high-pressure belt to low-pressure belt. Wind can be grouped into two main types, namely local wind and planetary wind. Local winds are those which occur regularly or periodically, and blow for a short time and affect a small area of the earth's surface. Examples of local winds include land breeze, sea breeze, mountain wind and valley wind.

Sea breeze

Sea breeze refers to the wind that blows from the sea to the land during the day. During the day the land heats up quickly than the sea and becomes warmer than the sea, and the air pressure on the land is lower than that of the sea. Therefore, wind blows from the sea to the land (Figure 4.9).

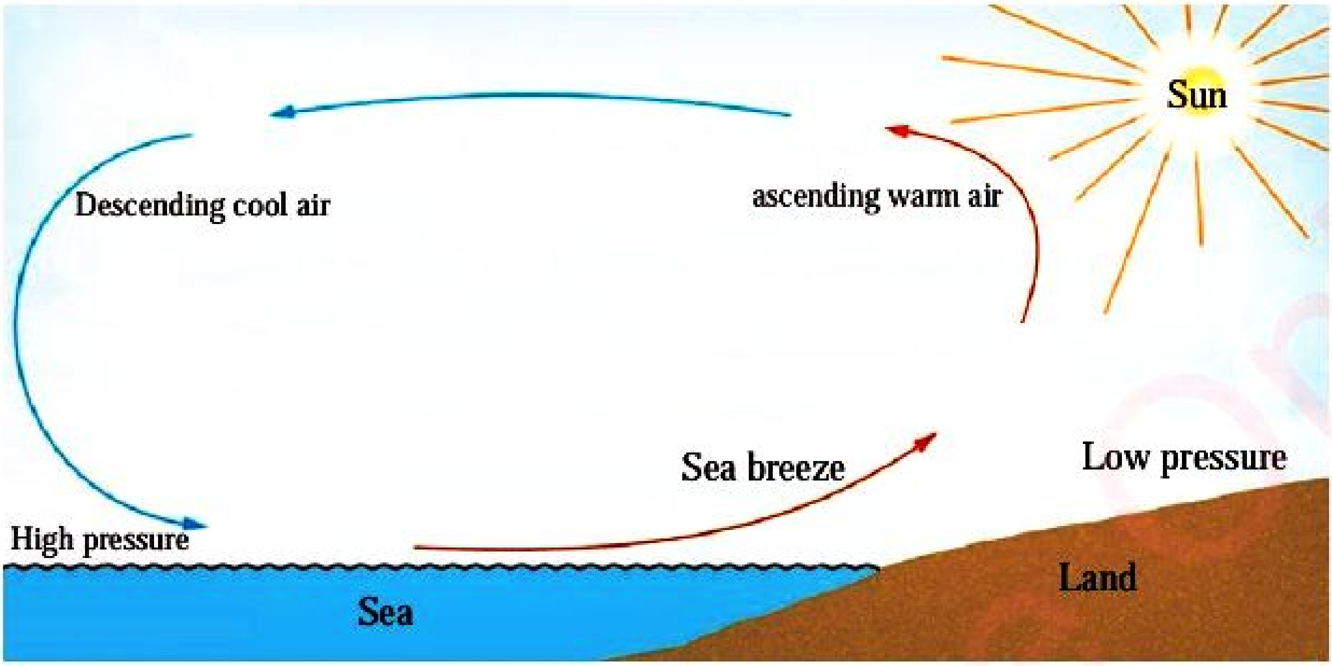


Figure. 4.9 Sea breeze

Land breeze

Land breeze refers to the wind blowing from the land to the sea during the night. During the night, the land cools quickly than the sea and therefore low pressure develops on the sea. Therefore, winds blow from land to the sea (Figure 4.10).

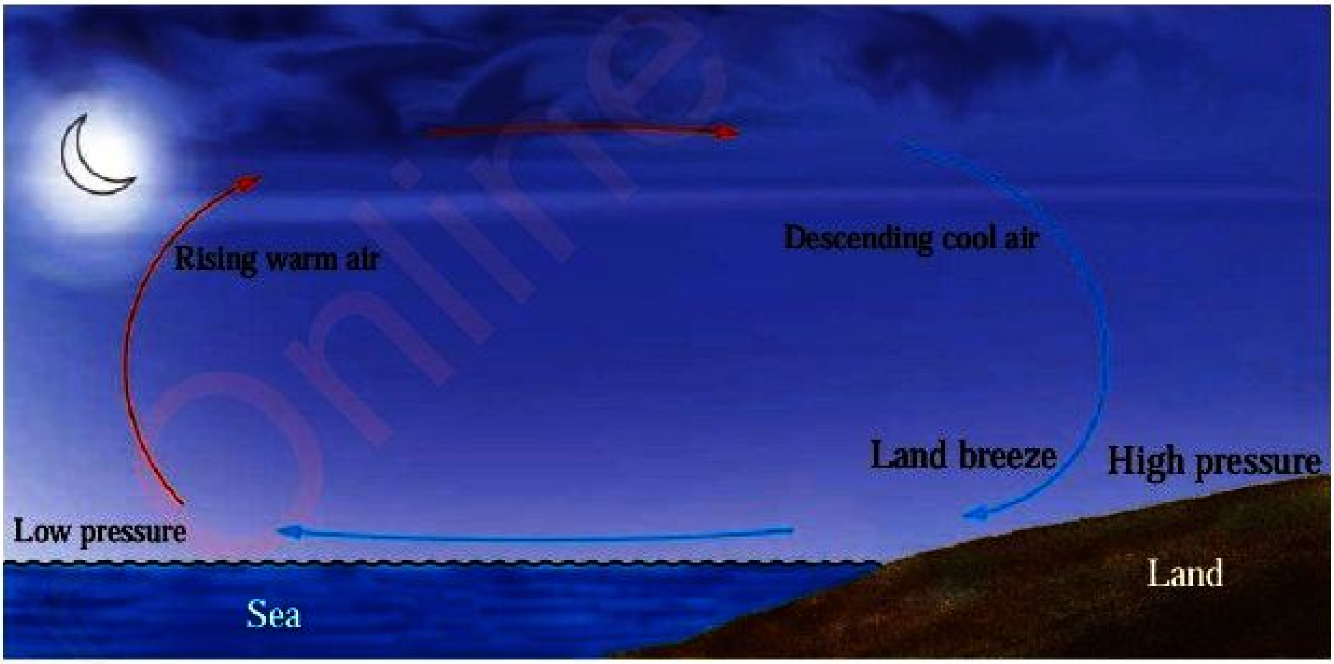


Figure 4.10 Land breeze

Planetary wind

Planetary wind refers to the winds which affect the large part of the earth's surface. They are sometimes called prevailing winds. Planetary wind can be grouped as *Trade Winds*, Mid-latitude *Westerlies* and *Polar easterlies* (Figure 4.11)

(i) **Trade winds**

These are winds that blow from sub-tropical high pressure belts 30° North and South towards the equatorial low pressure belt. In the northern hemisphere, the trade winds blow from North-East while in the southern hemisphere they blow from the South-East. Therefore, the North-East trade winds and South East trade winds converge or meet along the zone of low pressure belt known as the Inter-tropical Convergence Zone (ITCZ or Doldrums). This zone of low pressure lies near and almost parallel to the equator. The seasonal movement of the equatorial low pressure system causes a similar movement of the intertropical convergence zone.

(ii) **Mid-latitude Westerlies**

These refer to the type of prevailing winds which blow from the sub-tropical high pressure belt 30° north and south of the equator towards the sub-polar low pressure belt. In the northern hemisphere the wind blows from south west while in the southern hemisphere wind blows from north west due to the influence of earth's rotation.

(iii) **Polar Easterlies**

These are dry, cold prevailing winds that blow around the high pressure areas of the polar highs at the North and South poles. Cold air subsides at the poles creating high pressure zones.

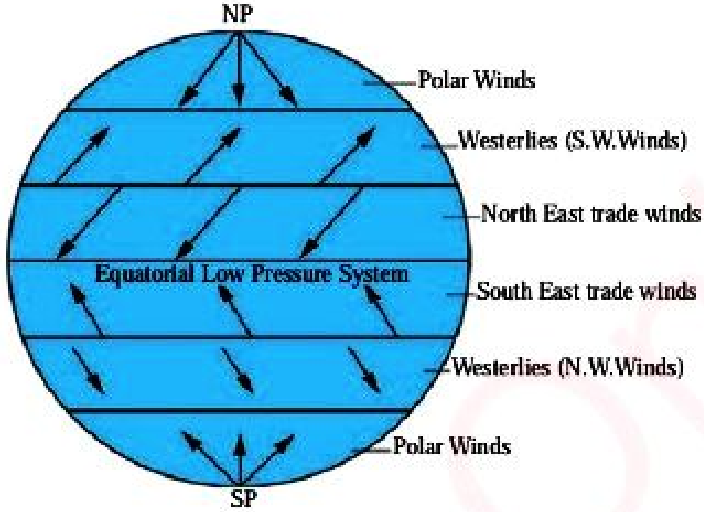


Figure 4.11 Wind systems

Importance of wind

Wind is important in our daily lives because it:

(i) Helps fishermen and traders to sail using dhows and canoes.

(ii) Promotes water sports.

(iii) Distributes moisture in the world which is important in rain formation.

(iv) Enables pollination of plants.

(v) Distributes temperature in the world for precipitation.

(vi) Facilitates the generation of power that enables the generation of electricity and pumping of water (Wind energy).

Atmospheric pressure

The air surrounding the earth's surface forms the atmosphere. The atmosphere has weight. The force with which the weight of the atmosphere presses down per unit area is called *atmospheric* *pressure*. The atmospheric pressure is exerted equally in all directions. It is measured using an instrument called a barometer.

The atmospheric pressure is measured in millibars (mb). Lines drawn on a weather map joining areas with equal amount of atmospheric pressure are known as *Isobars*.

Factors affecting atmospheric pressure

Pressure varies on the earth's surface. The major factors that affect atmospheric pressure are *altitude*, *temperature* and *rotation of the earth*.

(i) Altitude

Atmospheric pressure decreases with an increase in the height above the sea level. At the sea level, atmospheric pressure is higher. As the altitude increases the atmospheric pressure decreases. For example, Figure 4.12 shows that at 4,000 m above sea level the atmospheric pressure is 600 mb. On the other hand, at 2,000 m above sea level the atmospheric pressure is 800 mb. When climbing mountains such as Mount Kilimanjaro and Mount Everest, climbers experience the decrease in pressure with the increasing altitude.

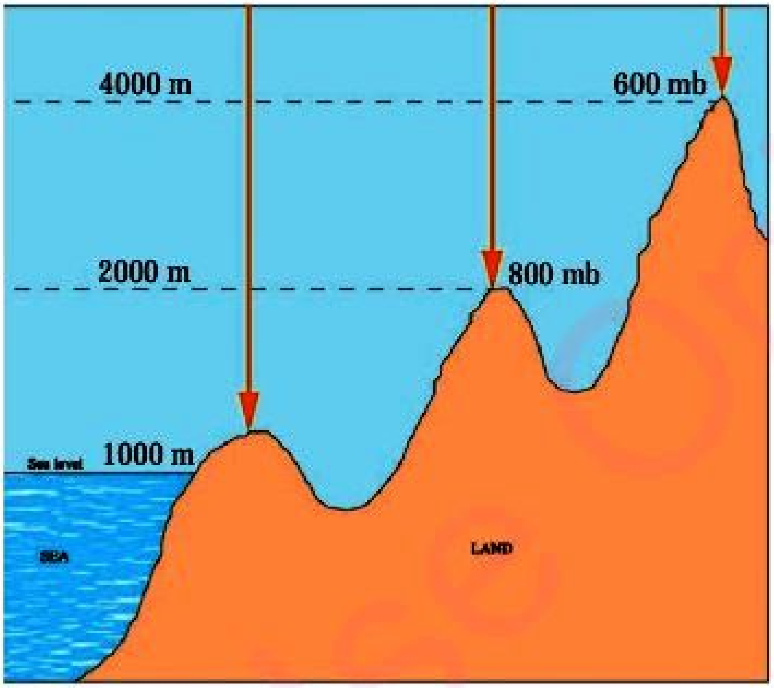


Figure 4.12 Relationship between pressure and altitude

(ii) Temperature

Temperature differences determine variations in pressure over the earth's surface. When air is heated, it expands, causing the molecules to spread over a large area. This lowers the atmospheric pressure of a particular area. Thus, areas with high temperature are characterised by low atmospheric pressure whereas areas with low temperature have high atmospheric pressure. For example, the equatorial region has low atmospheric pressure (Doldrums) due to high temperature.

(iii) Rotation of the earth

The earth's rotation causes air to move away from the poles. This air crosses the parallels towards the 60°N and 60°S. As it moves, the air expands so that its atmospheric pressure falls. That is why 60°N and 60°S have low atmospheric pressure.

Atmospheric pressure systems

Refers to the area of earth's atmosphere that has a particularly high or low pressure compared to the air around. In each hemisphere, there are three belts of pressure systems. These are *Equatorial low pressure* (doldrums), *sub-tropical high-pressure belt (Horse Latitude)*, *The sub-polar low-pressure belt*, and *Polar high pressure*. The equatorial low pressure (doldrums) is common in all hemispheres (Figure 4.13).

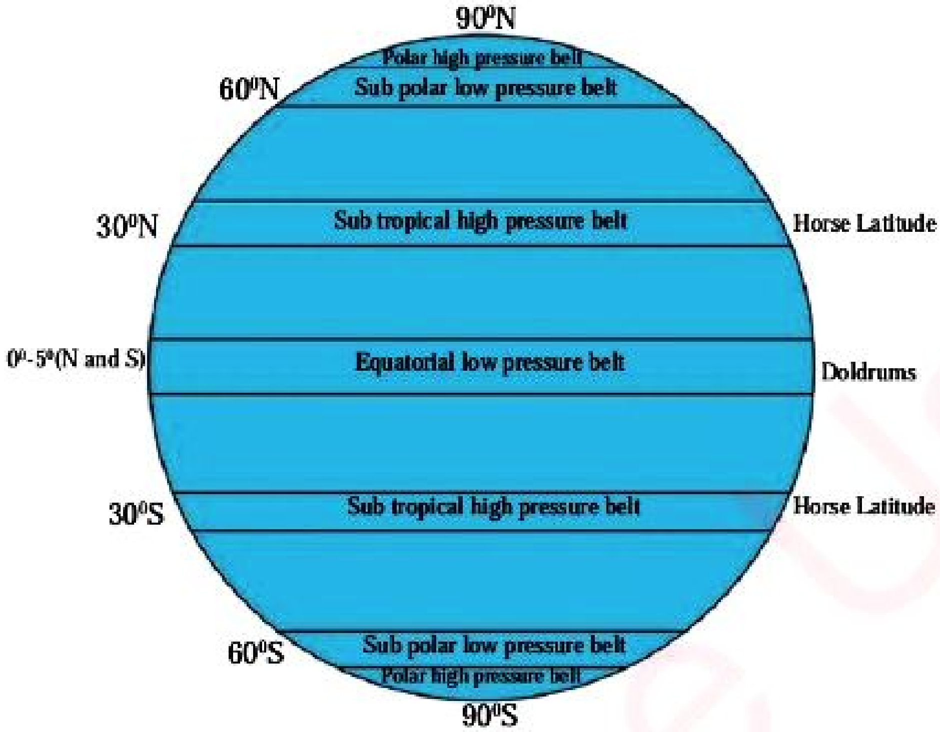


Figure 4.13 Wind pressure belts

The equatorial low-pressure belt (Doldrums) is located between 5° North and South of the equator. It is a belt of low pressure because of high temperature that causes the moist air to rise in great convection current. The sub-tropical high-pressure belt (Horse Latitude) lies 30° North and South of the equator. It is a belt of low temperature because of the rising air which spreads out and moves toward the poles which cools and sinks to form high pressure belt.

The sub-polar low-pressure belt is located between 60° North and South of the equator. It is a belt of low pressure because of the rotation of the earth. The polar high-pressure belt is located between 90° north and south of the equator. It is a belt of low temperature throughout the year because the cool air sinks down due to its high density, sinking of cold air results into high pressure in the polar region.

Importance of pressure

Atmospheric pressure is important to human lives. Humans experience two types of pressure: *external* and *internal* pressure. When external and internal pressure balance, they help normal breathing. When pressure exceeds or decreases, it may lead to difficulties in breathing. For example, when climbing higher altitudes such as on Mount Kilimanjaro one may experience difficulties in breathing as the altitude increases. Pressure does influence the speed and direction of winds and, therefore, the formation of clouds and rainfall.

Cloud cover

Clouds cover refers to the section of the sky that is covered/obscured by clouds when observed from a specific location. A cloud is a mass of small water droplets or ice crystals formed by the condensation of water vapour floating in the atmosphere. Lines drawn on a weather map joining areas with the same amount of cloud cover are known as *Isonephs*.

Types of clouds

There are different types of clouds depending on their appearance, shape and height in the sky. The four types of clouds (Figure 4.14) based on shape and heights are:

(i) High clouds are clouds located between 6,000 m to 12,000 m above the sea level. Example of these clouds are Cirrocumulus which are small rounded white ice crystal cloudlet which appear in long rows; Cirrostratus which are composed of a thin transparent sheet of ice crystals; and Cirrus which are composed of thin and fine ropes.

(ii) Middle clouds are found between 2,100 m to 6,000 m above the sea level. Example of these clouds are Altostratus which are grey or blue-gray clouds composed of water droplets in layers; and Altocumulus which are composed of water droplets in globular masses or rolls.

(iii) Low clouds extend below 2,100 m above the sea level. Example of low clouds are Stratus which are individual cloudlet, larger than those in altocumulus; Stratocumulus which are composed of large dark, rounded masses, usually in groups, lines or wavy patterns; and Nimbostratus which appear dark, grey, and shapeless, usually, they are rainy-looking and more often they produce a continuous rain or snow.

(iv) Clouds of great vertical extent, range from 1,500 m to 9,000 m above the sea level. They are formed at all levels. Example of clouds of great vertical extent are Cumulonimbus which are anvil shaped and have a great vertical extent and Cumulus which have low top and a flat base with a white grey globular mass like pieces of floating cotton.

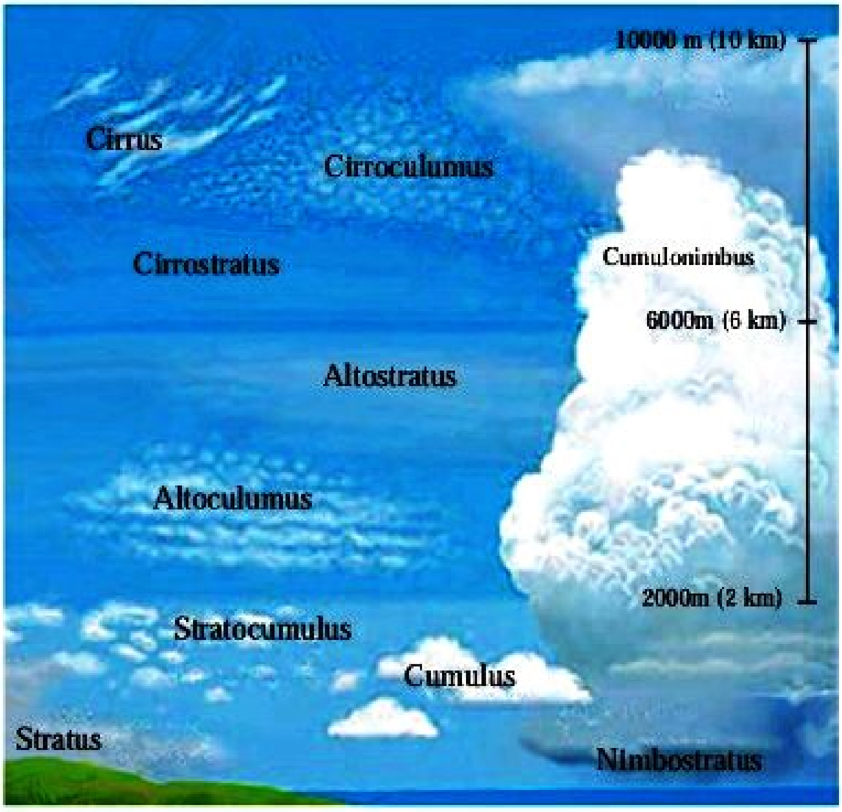


Figure 4.14 Types of clouds

Importance of clouds

(i) Clouds are important in the formation of precipitation.

(ii) Clouds help to regulate the earth's temperature by reflecting and scattering solar radiation and by absorbing heat energy emitted from the earth.

Activity 4.1

To show how atmospheric pressure exerts equally in all directions:

Procedure

1. Fill in a glass with clean water up to the top.
2. Cover the top of the glass with a piece of manila paper.
3. While holding the piece of paper firmly on the glass, turn the glass upside-down.
4. Stop pressing the piece of paper on the glass and observe. Is the water spilling? Give reasons for your answer?

Exercise 4.3

A: Choose and circle the most correct answer among the given alternatives:

1. One of the following is a set of factors that affect temperature:
   (a) Ocean current, distance from the equator, prevailing wind, altitude, water bodies and distance from the sea
   (b) Altitude, ocean current, distance from the sea, latitude, wind, cloud cover, aspect, length of a day
   (c) Altitude, temperature, rotation of the earth
   (d) Humidity, absolute humidity, relative humidity, sleet
   (e) Dew, mist, fog, rain, hail and snow

2. Solid precipitation falling down with small balls or irregular humps of ice is referred to as:
   (a) Snow (d) Rainfall
   (b) Hail (e) Frost
   (c) Sleet

3. If the temperature for Dar es Salaam at 100 m above the sea level is 30 °C what is the temperature for Moshi at 3,200 m above the sea level?
   (a) 19.2 °C (d) 29 °C
   (b) 11.4 °C (e) 30 °C
   (c) 10.8 °C

4. Planetary winds refer to:
   (a) Wind blowing from the land to the sea
   (b) Wind which occur regularly
   (c) Wind that affect the large part of the earth's surface
   (d) Wind blowing for a short time

5. Lines drawn on a weather map joining areas with the same amount of cloud cover are known as:

(a) Isonephs. (c) Isobars

(b) Isotherms (d) Isohyets

6. .... is a result of rise and condensation of water vapour into a liquid droplet

(a) Hail (c) Rainfall

(b) Snow (d) dew

7. The temperature at which the atmosphere is saturated with water vapour refers to as:

(a) Condensation

(b) Dew point

(c) Nuclei

(d) Relative humidity

(e) Absolute humidity

8. The decrease in temperature with the increase in altitude is called:

(a) Lapse rate

(b) Isotherms

(c) Temperature inversion

(d) Latitudinal

(e) Sunshine

B: Read the following statements and then write T for a TRUE statement and F for a FALSE one:

1. Humidity refers to the deposition of moisture from the atmosphere onto the earth's surface.

2. Prolonged lack of rain may result in drought conditions that may lead to shortage of food.

3. Mist is a mixture of snow and rain.

4. Dew point is the temperature at which the atmosphere is saturated with water vapour.

5. The side of the mountain facing the direction of the winds is called leeward.

C: Answer the following questions:

1. Outline the importance of temperature to human and plant life.

2. Describe the problems which may be caused by heavy rainfall.

3. Differentiate between sea breeze and land breeze.

4. Describe the formation of cyclonic rainfall.

5. Specify with reasons what type of rainfall is most common along the coasts of Tanzania.

The Stevenson screen

Every standard weather station has a Stevenson screen. It is a wooden box in which some of the instruments for measuring weather elements are kept (Figure 4.16). The instruments kept in the Stevenson screen are maximum thermometer, minimum thermometer, Wet bulb thermometer and Dry bulb thermometer.

Figure. 4.16 A Stevenson screen

Source: http://www.bom.gov.au/climate/cdo/about/airtemp-measure.shtml

A Stevenson screen is a wooden white-painted box mounted on four stands. This box has louvered sides to allow free circulation of air. It is white painted to reflect solar radiation. Its roof is insulated to prevent the sun's heat to reach inside. The louvers and the roof provide shade for the thermometers. Shade is important to avoid direct solar radiation and ensure correct temperature readings. The Stevenson screen is mounted on a stand 121 cm above the ground to prevent it from the heat effects radiated by the earth's surface.

Types of Stevenson screens

There are two types of Stevenson screens based on their size:

a) *Small Stevenson screen.* This type has various instruments such as wetbulb thermometer and dry bulb thermometer.

b) *Large Stevenson screen.* This contains maximum and minimum thermometers, wet and dry bulbs, a hygrothermograph, barometer and a dewcell.

Activity 4.2

1. Visit a weather station near your school and study its main features.
2. Go around your school compound and locate a suitable site for establishing a weather station. Give reasons for your choice.

Instruments that measure the elements of weather

There are different instruments used to measure the elements of weather such as the *thermometer, hygrometer, rain gauge, barometer, wind vane, anemometer* and the *sunshine recorder.*

Thermometers

A themometer is an instrument for measuring temperature. There are several types of thermometers. These are *maximum thermometer*, *minimum thermometer*, *wet bulb thermometer*, *dry bulb thermometer* and *the six's thermometer.*

(i) Maximum thermometer

The maximum thermometer is used to measure the highest temperatures between the readings. It has a metal index. It is made of glass and it contains mercury in a bulb. A mercury column extends from a bulb at one end of the thermometer inside a capillary tube to the metal index. The length of the mercury column shows changes in temperature (Figure 4.17).

When temperature rises, the mercury expands and the length of the column increases, pushing along the metal index. The maximum temperature is read from the side of the metal index nearest to the mercury. When the temperature falls the mercury column falls, leaving behind the metal index still indicating the maximum temperature reached. After recording the maximum temperature, a magnet is used to bring back the metal index into contact with the mercury.

(ii) Minimum thermometer

The minimum thermometer is used to measure the lowest temperature reached between the readings. It is made of glass, but it contains alcohol instead of mercury. Alcohol is used because it has lower freezing point than mercury (Figure 4.18). The minimum thermometer also has a metal index. Any fall in temperature will cause the alcohol column to contract and the meniscus (the curved upper surface of the alcohol column) will pull the index back along the tube. Whenever temperature rises, the alcohol will expand and flow freely past the metal index without pushing it up. Therefore, the metal index is always left as a record of the lowest temperature reached between the readings. The part of the metal index away from the bulb will indicate the lowest temperature reached.

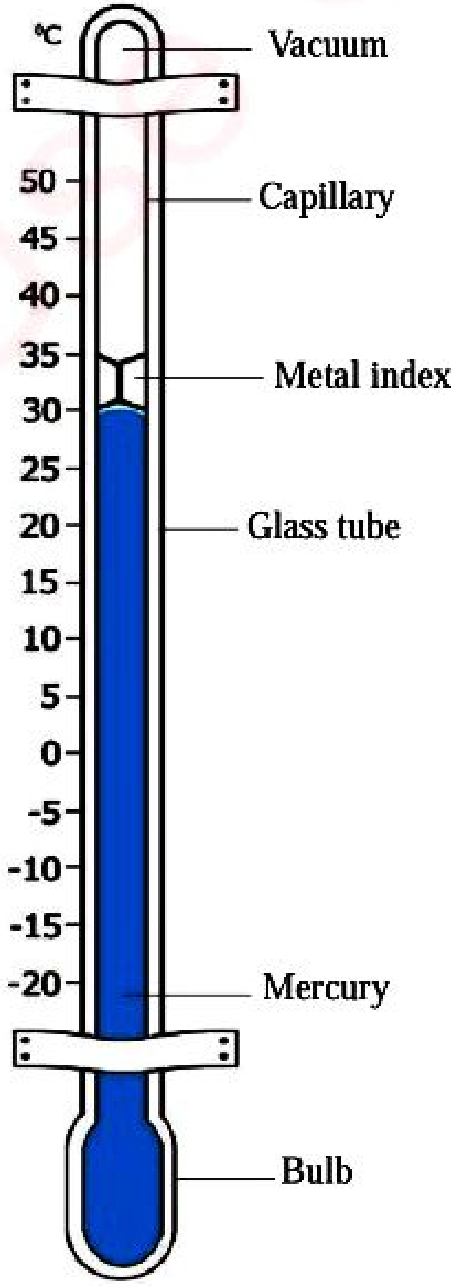


Figure 4.17 Maximum thermometer

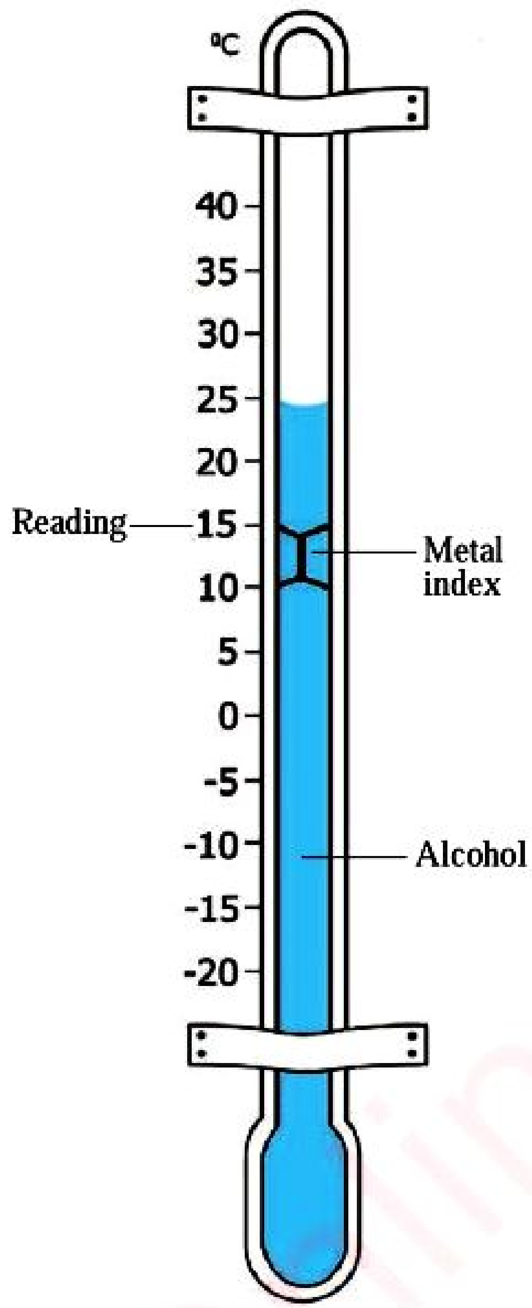


Figure 4.18 Minimum thermometer

(iii) The six's thermometer

The Six's thermometer can be used for measuring both maximum and minimum temperatures (Figure 4.19). This thermometer consists of a "U" shaped glass tube. The side with a bulb records the minimum temperature and the other side records the maximum temperature. When the temperature rises, the alcohol in the bulb expands and pushes the mercury in the tube. Maximum temperature is read from the bottom end of metal index (A). When the temperature falls, the alcohol in the bulb contracts. This causes the mercury to push metal index (B) towards the bulb. The minimum temperature is read from the part of metal index (B) from the mercury

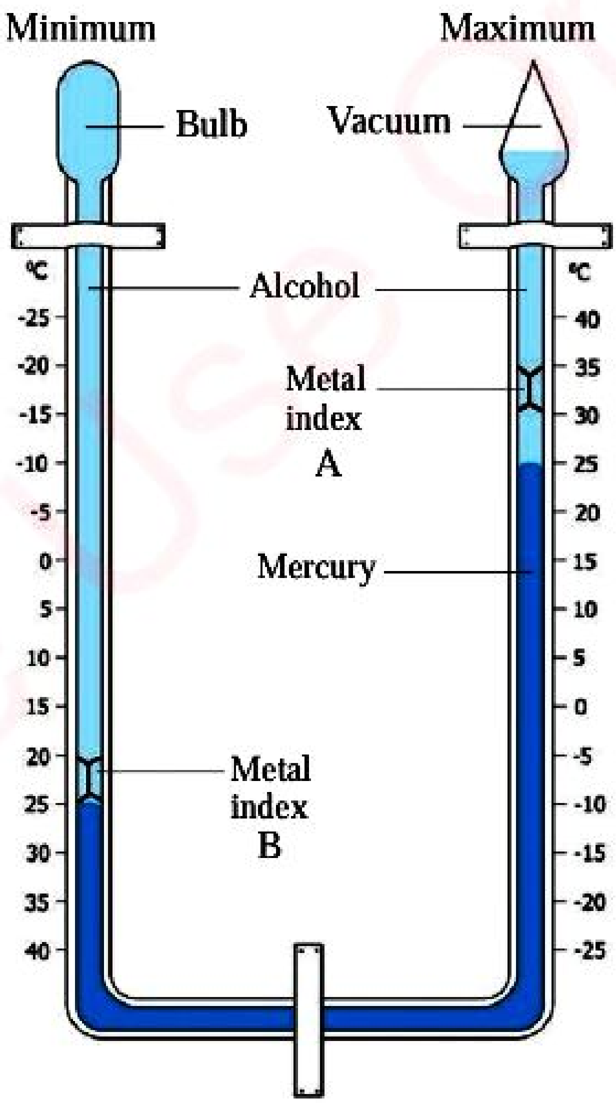


Figure. 4.19 Six's thermometer

Measuring and recording temperature

Temperature readings are taken every day at regular and fixed intervals. The intervals can be four hours, six hours or even twenty-four hours. In some meteorological stations, a self-recording instrument called thermograph records temperatures continuously. In each measurement, minimum and maximum temperatures are recorded. The minimum and maximum temperature recorded are used to calculate the following:

(i) The daily range of temperature
(ii) The mean daily temperature
(iii) The monthly range of temperature
(iv) The mean monthly temperature
(v) The annual range of temperature
(vi) The mean annual temperature

The daily range of temperature

The daily range of temperature is the difference between the maximum and minimum temperatures recorded in a day. The daily range of temperature is recorded daily throughout the year. For example, the minimum and maximum temperatures recorded in Dar es Salaam on May 23rd 2014 were 23.5 °C and 32.5 °C, respectively. Therefore, the daily range of temperature is calculated as follows:

Temperature Range

= Daily Max. Temp. - Daily Min. Temp.

= 32.5 °C – 23.5 °C

= 9.0 °C

Therefore, the range of temperature in Dar es Salaam for that day was 9.0 °C.

The mean daily temperature

The mean daily temperature is the average of the maximum and minimum temperatures recorded or the average of the total number of observations or recordings in a day. Mean daily temperatures are recorded daily throughout the year. For example, the minimum and maximum temperatures recorded in Dar es Salaam on May 23rd 2014 were 23.5 °C and 32.5 °C, respectively. Therefore, the mean daily temperature is calculated as follows:

Mean Daily Temp

$$= \frac{\text{Daily max. Temp + Daily Mini. Temp}}{2}$$

$$= \frac{32.5\ ^\circ C + 23.5\ ^\circ C}{2}$$

$$= \frac{56\ ^\circ C}{2} = 28\ ^\circ C$$

Therefore, the mean daily temperature was 28.0 °C.

Alternatively, sum up all the observations in a day then divide by 24 hours.

The monthly range of temperature

The monthly range of temperature is the difference between the highest mean daily temperature and the lowest mean daily temperature in a month. For example, if the highest mean daily temperature for the month of July 2014 in Dar es Salaam was 29.5 °C recorded on 8th July and the lowest was 17.0 °C recorded on 23rd July, then the monthly range of temperature for the month of July is calculated as follows:

Monthly Range Temp.

= Monthly Max. mean Temp. - Monthly Min. mean Temp.

= 29.5 °C - 17.0 °C.

= 12.5 °C

Therefore, the monthly range of temperature was 12.5 °C.

Annual range of temperature

The annual range of temperature refers to the difference between the highest monthly temperature and the lowest monthly temperature in a year. For example, the temperature recorded in Dar es Salaam in 2016 is shown in Table 4.1

Table 4.1 Mean Monthly temperature of Dar es Salaam in 2016

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature °C	28	27	28	24	27	28	29	28	28	29	30	30

The annual range of temperature = highest monthly temperature minus lowest monthly temperature

$$= 30\ °C - 24\ °C$$
$$= 6\ °C.$$

Therefore, the annual range of temperature for Dar es salaam in 2016 was 6 °C.

The mean annual temperature

The mean annual temperature of a particular year is obtained by adding the monthly temperatures of a year and dividing it with the number of months in a year. For example, using data in Table 4.1 the mean annual temperature of Dar es Salaam is calculated as follows:

$$\text{Mean Annual Temp.} = \frac{\text{Sum of the Monthly for 1 year}}{\text{12 Months}}$$

$$\text{Mean Annual Temp} = \frac{(28+27+28+24+27+28+29+28+28+29+30+30)\ °C}{\text{12 Months}}$$

$$\text{Mean Annual Temp.} = \frac{336\ °C}{12}$$

$$\text{Mean Annual Temp.} = 27.75\ °C$$

Therefore, the mean annual temperature of Dar es Salaam in 2016 was 28 °C.

Temperature conversion

The measurement of temperature can be converted from one scale to another, for example, from degree Centigrade (°C) to degree Fahrenheit (°F) or from degree Fahrenheit to degree Centigrade (°C). The formulae used for conversions are:

(a) Degree Centigrade into degree Fahrenheit:

$$ϒF = \frac{9}{5}ϒC + 32 \quad \text{or}$$

$$°F = 1.8\ °C + 32$$

(b) Degree Fahrenheit into Degree Centigrade:

$$°C = \frac{5}{9}(°F - 32) \text{ or}$$

$$°C = 0.6\ (°F - 32)$$

Example 1: Convert 33 °C into degree Fahrenheit.

$$\text{If } ϒF = \frac{9}{5}ϒC + 32$$

$$\text{Then} \quad °F = \frac{9}{5} \text{ x } 33 + 32$$

$$= \frac{297}{5} + 32$$

$$= 59.4 + 32$$

Therefore $33\ °C = 91.4\ °F$

Example 2: Convert 41 °Fahrenheit into degree Centigrade.

$$\text{If} \quad °C = \frac{5}{9}(°F \quad 32)$$

$$\text{Then } °C = \frac{5}{9}(41 \quad 32)$$

$$= \frac{5}{9} \text{x} 9$$

Therefore, $41\ °F = 5\ °C$

Exercise 4.4

Answer the following questions

1. After recording the maximum temperature in the minimum and maximum thermometer, which instrument is used to bring back the metal index?
   (a) Thermometer
   (b) Hygrometer
   (c) Magnet
   (d) mercury
2. The minimum and maximum temperature recorded are used to calculate:
   (a) Daily range of temperature
   (a) Annual temperature
   (a) Monthly temperature
   (a) Alcohol temperature
   (a) Relative temperature
3. Explain how you can calculate the following:
   (a) The mean annual range of temperature.
   (b) The mean annual temperature.
4. Convert each of the following temperatures expressed in degrees Centigrade into degrees Fahrenheit.
   (a) 55 °C (c) 24.3 °C
   (b) 18 °C (d) 30 °C
5. Convert each of the following temperatures expressed in degrees Fahrenheit into degree Centigrade:
   (a) 45 °F (c) 98.42 °F
   (b) 62 °F (d) 180 °F

$$= \frac{\text{Total annual rainfall}}{\text{12 months}}$$

$$= \frac{1923}{12}$$

$$= 160.25 \text{ mm}$$

Places with the same amount of rainfall on a weather map are joined by smooth lines called *Isohyets* (Figure 4.25).

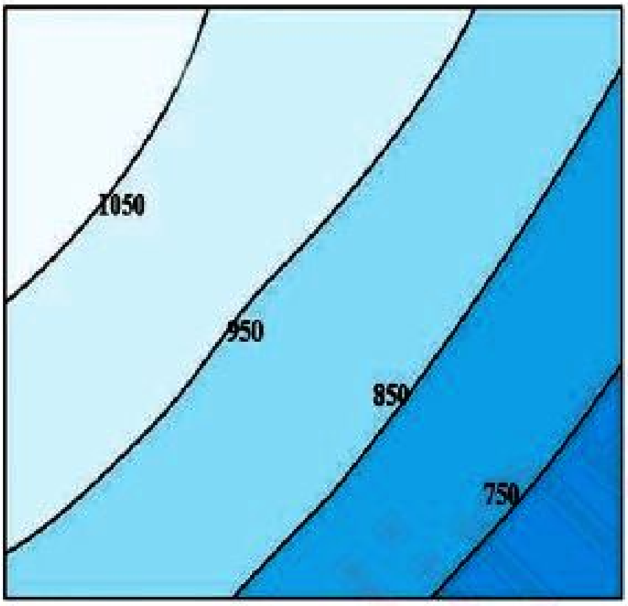


Figure 4.25 Isohyets

A climograph is a graphical representation of basic climatic variables that is monthly average temperature and precipitation at a certain location. It is used for a quick view of the climate of a place in terms of the relationship between temperature and rainfall patterns. The climograph is drawn by combining temperature and rainfall data in bar and line graph. Usually bars represent rainfall and a line represents temperature (Figure 4.26).

Table 4.3 Temperature and rainfall distribution

Months	Temp °C	Rainfall (mm)
J	22	8
F	23	8
M	22	17
A	19	43
M	16	124
J	13	167
J	12	162
A	13	142
S	14	83
O	16	53
N	18	20
D	22	15

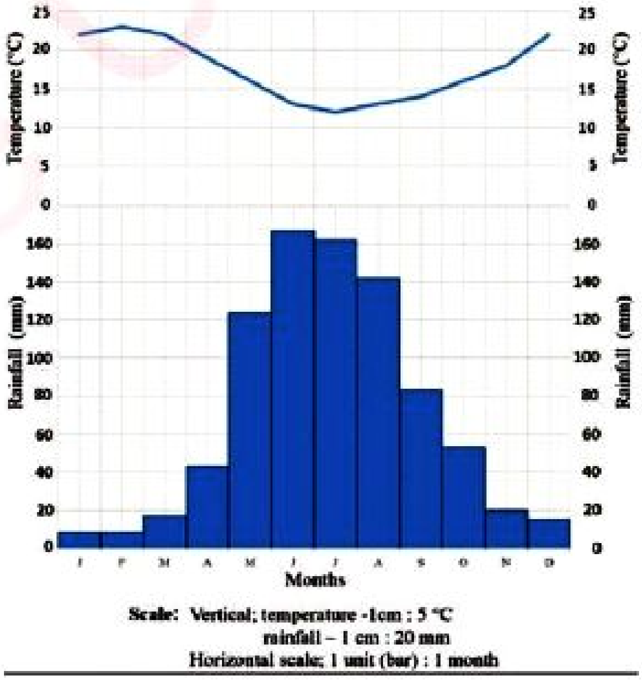


Figure 4.26 Monthly temperature and rainfall

The barometer

A barometer is an instrument for measuring atmospheric pressure. There are two types of barometers: *mercury barometer* and

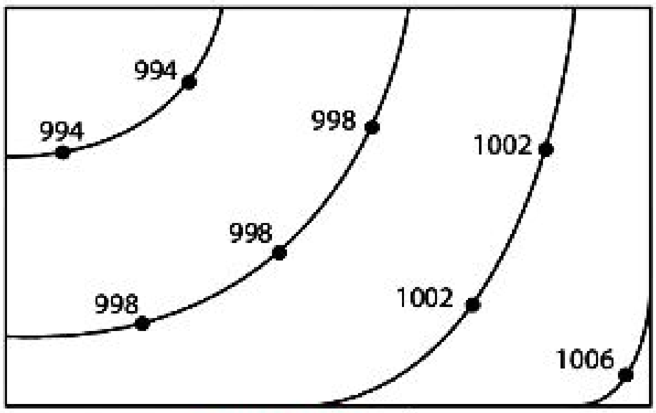


Figure 4.28 Isobars

Wind Vane

Wind direction is measured by a wind vane (Figure 4.29). A wind vane consists of a freely rotating arrow fitted to a central rod. The arrow of the wind vane always points to the direction to which the wind blows. The wind is named after this direction. Four arms marking the direction of the cardinal points are fixed to the stationary central rod.

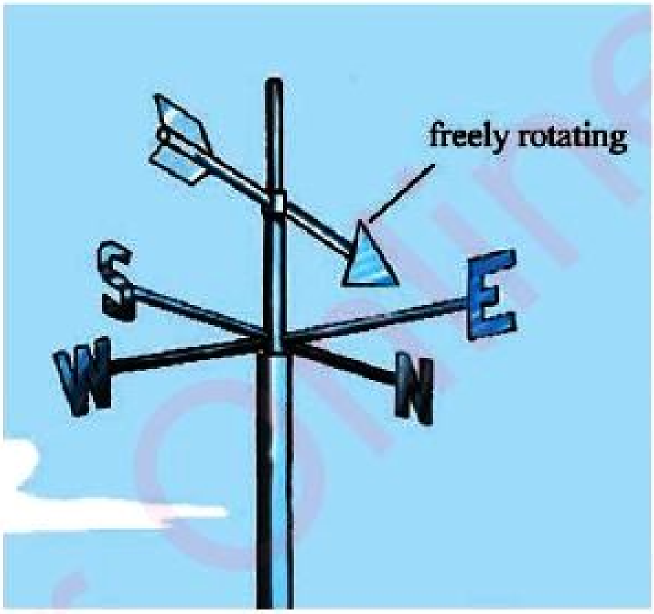


Figure 4.29 A wind Vane

Anemometer

Wind speed is measured by an instrument called *anemometer* (Figure 4.30). This instrument consists of three or four horizontal arms pivoted on a vertical shaft. Metal cup is fixed to each end of each arm so that when there is wind the arms rotate. This movement operates a meter which records the speed of the wind in kilometres per hour.

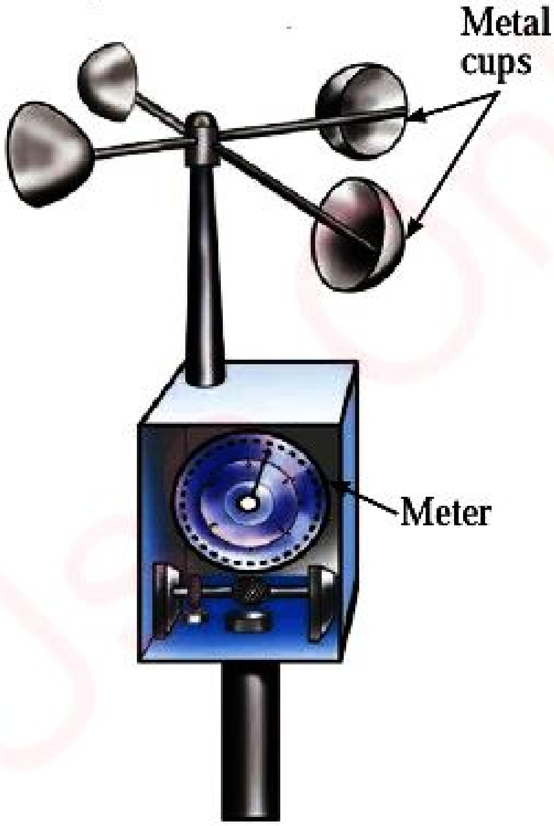


Figure 4.30 Anemometer

Campbell-Stokes sunshine recorder

The duration of sunshine a place receives each day is measured by an instrument known as Campbell-Stokes sunshine recorder (Figure 4.31). The sunshine recorder is made of a glass sphere surrounded by a metal frame. The glass sphere is used to detect the sun's radiation. Inside the metal frame, there is a sensitive card to record the amount of sun rays during a day. As the earth rotates, it changes the direction of the sun and rays from the sun, which burns a trace on the card. When the sun sets, the card is removed and the length of a trace is converted into hours and minutes. *Isohels* are lines drawn on a weather map joining places with the same amount of sunshine.

Figure 4.31 Campbell-Stokes sunshine recorder

Source: https://www.amusingplanet.com/2016/10/campbellstokes-recorder-simple-device.html

Cloud measurement

The amount of cloud cover is estimated in *Oktas*. One Okta represents about one-eighth of the sky covered with cloud. The symbols used to represent the amount of cloud cover on weather maps range from 0 oktas (completely clear sky) to 8 oktas (fully covered) as Figure 4.32 illustrates:

Figure 4.32 Weather map symbols showing amount of cloud cover

Weather forecasting

Weather forecasting is a prediction of weather condition of a place at a given time. Weather forecasting is obtained using two methods: *Traditional* and *modern* methods. The traditional method predicts weather through the observation of types of birds, crocking frogs, rainbow, migration of birds, changes in wind direction, position of the moon, flowering and sprouting of plants.

The method is still widely used in predicting weather by indigenous communities. The modern method, on the other hand, involves the use of modern equipment such as meteological satellites, radar, aircraft, computers, balloons, ships, submarines, rockets and daily records from weather stations. This method is more reliable and accurate than the traditional method.

Importance of weather forecasting

Weather forecasting is useful to people as it:

(1) Allows people to prepare and respond efficiently to hazards and disasters such as floods, hurricanes, tornadoes, droughts and tsunamis.

(ii) Provides the necessary information to help farmers to know when to plan for different agricultural activities such as planting, farm preparation and harvesting.

(iii) Provides supportive information to fishing communities for planning their fishing activities regarding the movement of fish in lakes and oceans.

(iv) Guides countries on when to carry out military operations.

(v) Helps people to choose suitable clothes, sport activities and means of transportation.

(vi) Provides information for planning of tourism activities.

(vii) Helps the ocean-going vessels (sailors) to know about the conditions of the atmosphere.

Exercise 4.5

A: Choose and circle the most correct answer from the given alternatives:

1. Which of the following is the correct formula for calculating the mean monthly temperature of a place?

(a) $\frac{\text{The sum of mean daily temperature for the month}}{\text{Number of days in a month}}$

(b) $\frac{\text{The sum of monthly temperature x12}}{\text{Number of days in a month}}$

(c) $\frac{\text{The sum of monthly temperature for the year}}{\text{12 months}}$

(d) $\frac{\text{The daily maximum temperature + the daily minimum temperature}}{2}$

(e) $\frac{\text{The maximum temperature - minimum temperature}}{2}$

2. Lines on a weather map joining places with the same amount of atmospheric pressure are called:

(a) Isolines (b) Isohyets (c) Isotherms
(d) Isobars (e) Latitudes

3. The atmosphere is said to be most humid only when:

(a) is saturated with water vapour

(b) is unsaturated with water vapour

D. **Match each statement in Column A with its corresponding response in Column B.**

Column A	Column B
(i) Instrument used to measure humidity.	(a) Wind vane
(ii) Instrument used to measure amount of rainfall.	(b) Isotherms
(iii) Lines joining places with the same amount of rainfall.	(c) Rain gauge
(iv) Instrument used to measure wind speed.	(d) Isohyets
(v) Lines joining places with the same pressure.	(e) Isobars
(vi) The rate at which air temperature decreases with altitude.	(f) Hygrometer
(vii) Wind blowing from the sea to the land.	(g) Anemometer
(viii) Mixture of snow and rain.	(h) Oktas
(ix) Units for measuring amount of cloud cover.	(i) Barometer
(x) Rain formed when two air masses of different characteristics meet.	(j) Stevenson's screen
	(k) Sleet
	(l) Sea breeze
	(m) Lapse rate
	(n) Land breeze
	(o) Hail
	(p) Prevailing wind
	(q) Cyclonic Rainfall
	(r) Relief Rainfall
	(s) Convectional Rainfall

Climate

At the beginning of this chapter, you were introduced to the concept of weather and climate. You have learned about weather, its elements and how they are measured. In this section, you will learn about the meaning of climate, factors that determine climate, relationships between weather and climate, and types of climate and their relationship with human activities.

Climate is the average weather conditions of a place observed and recorded over a long period of time, usually over 30 years.

The climate of a particular place is determined by the latitude and tilt of the earth on its axis, distribution of land, sea and ocean currents, altitude and topography, prevailing winds, the nature of earth's surface and vegetation.

Relationship between climate and weather

Climate and weather are closely related because climate is established by a study of the average conditions of the elements of weather. Any change in weather condition overtime has an influence on climatic changes in the same place. In determining the climate of an area, the mean values of each of the elements of weather are recorded each year for 30 years or more. The mean values are summed and the average calculated by dividing the total value for each element by the total number of years for which the values were recorded.

The average values obtained are used to describe the climate of an area. For example, if the average annual rainfall is 1800 mm and temperature is 31°C, then it can be concluded that the climate of the area is characterised by high rainfall and high temperature. If the average annual rainfall is 400 mm and temperature is 31°C, then it can be concluded that the area is characterised by low rainfall and high temperature. The description of the climate of an area includes also the values such as humidity, pressure and wind.

Similarities and differences between weather and climate

Climate and weather are similar in the following ways:

(i) Both describe atmospheric conditions of an area.

(ii) Both are determined by the same elements.

(iii) Both determine socio-economic activities of an area.

(iv) Both contribute to the survival and distribution of living organisms.

Climate and weather differ in the following ways:

(i) Weather refers to the condition of the atmosphere recorded over a short period of time (minute to minute, hour to hour and day to day) whereas climate is a condition of the atmosphere recorded over a long period of time usually 30 years or more.

(ii) Weather can change quickly whereas climate changes more gradually and takes a long time for its changes to be established.

(iii) Weather forecasting is based on short-term recorded weather elements whereas climate projections require weather data that have been recorded over a long time.

(iv) The description of weather is based on a small area whereas that of climate is based on a large area.

(v) The scientific study of weather is called meteorology whereas that of climate is called climatology.

(vi) Weather may involve one or two conditions of the atmosphere whereas climate includes many conditions of the atmosphere such as temperature, precipitation, wind, humidity, cloud cover and atmospheric pressure.

(vii) Climate has distinct seasons such as hot and wet or cool and dry seasons whereas weather changes occur on a day-to-day basis.

Types of climate and their relationship with human activities

Our world has some regions which are hot and others are cold, some are very dry while others have plenty of rainfall all the year round. It is not surprising to find that in one country there are different climates. The different climatic conditions support different human activities. Basically, there are five climatic conditions as follows:

The equatorial climate

This type of climate occurs between 5° North and to 5° South of the equator. Places which experience equatorial climate include; the Congo basin in Central Africa, the costal low lands of Gulf of Guinea in West Africa and the Amazon Basin in South America. The characteristics of equatorial climate are:

(i) High temperature throughout the year with an average daily temperature of $26\ ^{\circ}C$.

(ii) Heavy rainfall throughout the year and generally accompanied by lightning and thunderstorms.

(iii) High humidity throughout the year due to high temperature and extensive cloud cover.

(iv) The diurnal temperature range is between $6\ ^{\circ}C$ and $8\ ^{\circ}C$, which is greater than the annual range of about $3\ ^{\circ}C$.

(v) The mid-day sun is always near the vertical and is overhead twice a year, at equinoxes.

(vi) There are no seasons because the latitudinal belt lies under the Doldrums low pressure all the year round.

(vii) The natural vegetation in this region is a thick forest called selva, the forest is always green with interlaced canopy.

Table 4.5 Hypothetical data for an equatorial climate

Month	Temperature	Rainfall(mm)
J	23	200
F	24	338
M	24	433
A	24	355
M	24	275
J	24	230
J	26	160
A	26	70
S	27	25
O	26	15
N	26	50
D	24	230

Human activities in the equatorial climate are:

(i) Crop cultivation is practised due to the presence of enough rainfall and fertile soil. Example of crops cultivated include cocoa in Ghana, palm oil in Nigeria and rubber in Liberia.

(ii) Fishing activities are also conducted due to the presence of large water bodies such as River Congo, Zambezi, Limpopo and Amazon lakes.

(iii) Lumbering activities are also done due to the presence of thick forests and woodland which provide building materials. For example, the Congo and Amazon forest.

(iv) Tourism activities also are conducted in the equatorial climate because of having tourist attraction features like forests and wild animals such as crocodiles, leopards, monkeys, gorillas and hippopotamus.

The tropical climate or the savannah climate

This type of climate occurs between 5° and 15° north and south of the equator. It is developed in East and Central Africa, east coast of Brazil, the lowlands of Central America and Central Australia. The characteristics of tropical or Savannah climate include:

(i) High temperature with an annual range of about 8 °C. The average temperature for the hot season is 29 °C and cooler season average temperature is 21 °C. Maximum temperature occurs when the sun is in an overhead position.

(ii) Heavy rain, mainly convectional type, fall in the hot season. The cool season is dry. The amount of rainfall decreases with the increase in distance from the equator.

(iii) Low humidity during dry season.

(iv) The vegetation of this region is called the savannah which is characterised by tall grasses and scattered trees.

Table 4.6 Hypothetical data for a tropical or savannah climate

Month	Temperature (°C)	Rainfall(mm)
J	28	250
F	26	208
M	26	208
A	26	100
M	25	55
J	24	15
J	26	10
A	28	30
S	28	48
O	27	110
N	23	145
D	26	200

Human activities in the tropical climate or savannah climate:

(i) Livestock-keeping is carried out due to the presence of enough grasses which are the main source of food for the livestock. Examples of animal kept include; cattle and goats.

(ii) Crop cultivation is also conducted with both cereal crops and cash crops such as beans, maize, millet, coffee and cotton being grown together to provide food and raw materials for the manufacturing industries.

(iii) Tourism activities are also carried out because of different tourist attractions such as the Serengeti, Ruaha and Mikumi National Parks. There is also Ngorongoro conservation area in Tanzania where animals such as elephants, zebras, giraffes and lions are found.

(iv) Hunting and gathering are carried out in this region because of enough wild animals, birds, and collection of fruits and eggs from the forest.

The hot desert climate

Hot deserts are located on western margins of land masses between 20° and 30° North and South of the equator. Hot desert occupies about one third of the earth's surface. Most deserts experience a temperature of about 40 °C in day time. Nights are cold with temperatures as low as 16 °C. The major world deserts are the Sahara deserts in Africa; the California desert in North America; the Atacama desert in South America; the Arabian deserts in Asia and Great Australian desert. The characteristics of hot desert climate are:

(i) Temperature varies from 29 °C in the hot season to 10 °C in the cool season.

(ii) There is no cloud cover therefore day temperatures go over 38 °C. At night, radiation is rapid and temperature can fall to 5 °C. Diurnal temperature ranges are therefore very high.

(iii) Rainfall rarely falls. The average annual fall is usually below 120 mm.

Table 4.7 Hypothetical data for a desert climate

Month	Temperature (°C)	Rainfall(mm)
J	13.3	2.5
F	16.1	2.5
M	20	0
A	25	0
M	28.9	0
J	35	0
J	36.7	2.5
A	35.8	0
S	32.8	0
O	26.7	5
N	19.1	2.5
D	14.4	15

Human activities in the hot desert climate:

(i) Crop cultivation is conducted under irrigation due to the presence of little or no rainfall. Few crops are cultivated such as date and palms which are cultivated near oases.

(ii) Livestock-keeping is practiced whereby donkeys, camels and goats are kept as source of food.

(iii) Hunting and gathering is also conducted in this region.

Mediterranean climate

The Mediterranean climate occurs in the area between 30° and 45°N and 30° to 40°S. The climate is best developed around the shores of the Mediterranean Sea, in south West Africa, Central Chile, Central California and south-west and southern Australia and South Africa (Cape Province). The Mediterranean climate has the following characteristics:

(i) Temperatures range from 21 °C in summer to 10 °C in winter.

(ii) Winters are rainy and mildly, and at times can cause floods. Onshore western winds bring cyclonic rainfall. The annual rainfall ranges from 500 mm to 760 mm

(iii) Summers are hot and dry, the sky is cloudless and humidity is low.

(iv) Off-shore trade winds blow in summer. These winds are dry and give no rain.

(v) The vegetation of this climate is evergreen with open woodlands coupled with scattered trees.

Table 4.8 Hypothetical data for a Mediterranean climate

Month	Temperature (°C)	Rainfall(mm)
J	22	18
F	22	15
M	21	23
A	18	46
M	16	95
J	14	111
J	13	96
A	14	88
S	17	56
O	20	41
N	17	27
D	13	94

Human activities in the mediterranean climate

(i) Crop cultivation is carried out, where by wheat, maize, and potatoes as well as fruits especially citrus are cultivated in the cape province of South Africa.

(ii) Lumbering activities are also conducted due to the presence of evergreen forests, woodlands and scattered trees.

(iii) Tourism activities are also conducted in this area due to good climatic conditions associated with sunny as well as the presence of sandy beaches which attract tourists.

Tundra climate

The Tundra climate is found between 45° and 90° North and South of equator. This region is very cold and covered with ice sheet. It is best developed in northern Canada and northern Asia. Tundra climate has the following characteristics:

(i) The region experiences very low temperature ranging from -29 °C to -40 °C in Winter and 10 °C in Summer. The annual range varies from 39 °C to 50 °C.

(ii) The annual precipitation is about 250 mm. This precipitation is in a form of snow in winter and rain in the summer.

(iii) Humidity is low because of low temperatures.

(iv) The natural vegetation consists of mosses, lichens, sedges and grasses. The Arctic scrub vegetation which tolerates such climate conditions.

Table 4.9 Hypothetical data for tundra climate

Month	Temperature (°C)	Rainfall(mm)
J	-18.9	7.6
F	-17.2	5
M	-10.6	7.6
A	0.5	10.2
M	10.5	25.4
J	16.7	35.6
J	19.4	45.6
A	16.1	40.6
S	10	22.9
O	1.7	22.9
N	-8.9	17.8
D	-15.6	15.2

Human activities in the tundra climate

The tundra region, where there are low temperatures, short summers and frozen soils, does not allow crop growing. As a

Chapter Five

Map work

Introduction

A map is an important tool for studying Geography. It represents information about locations, distances, distributions, areas, and directions of various features. In this chapter, you will learn about concept of map, components of map, quantitative information on maps and uses of maps. You will also learn how to use maps in your daily activities.

The concept of a map

The word "map" comes from two Medieval Latin words "*mappa mundi*" whereby "mappa" means napkin or cloth and "mundi" the world. Thus, map is a short form of "mappa mundi" to refer to a representation of the surface of the earth on the flat surface such as a paper, wall and cloth or wood. It represents a whole or part of an area of the earth's surface as viewed vertically from above. All maps are drawn using *scales.* The information given on a map is shown using conventional *signs* and *symbols* that are interpreted by the use of a *key*. A person who makes maps is called a *cartographer* whereas the science of making maps is known as *cartography*.

Activity 5.1

On a piece of paper:

(a) Draw a map of your classroom.

(b) Draw a map of your school.

Types of maps

There are two common types of maps. These are *topographical* and *statistical* maps. A map that shows important natural and man-made features is known as a topographical map. Topographical maps are very useful for geographers, students, tourists, engineers, ecologists, geologists and soldiers (Figure 5.1).

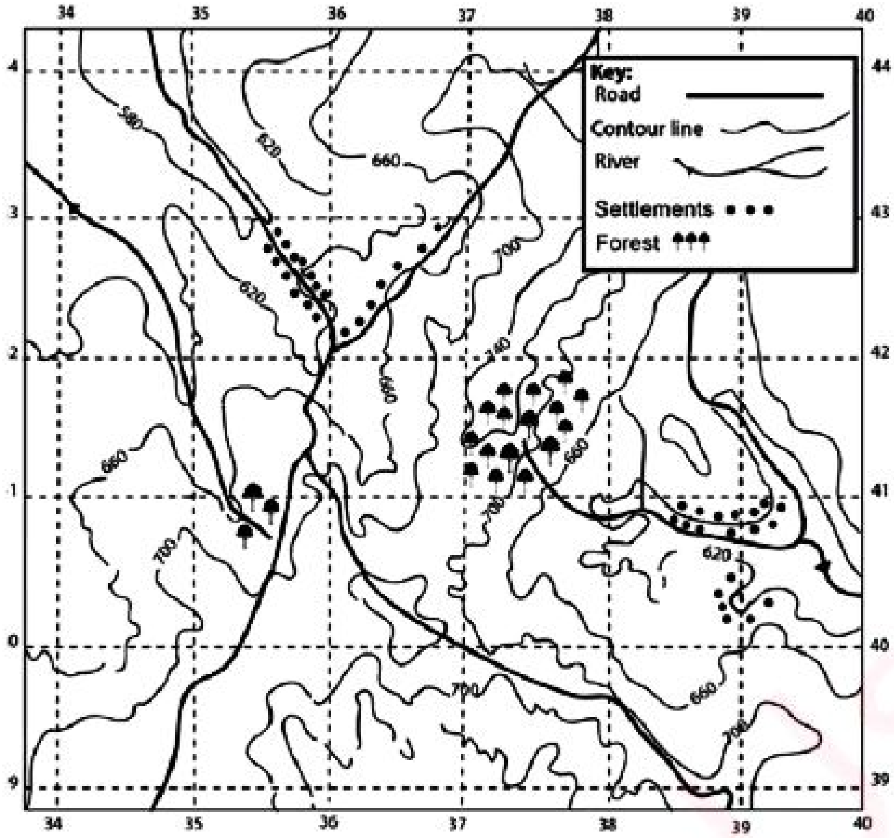


Figure 5.1 A topographical map

Some maps show the distribution of various geographical phenomena such as rainfall, temperature, pressure and popu lation. These are known as statistical or distribution maps (Figure 5.2).

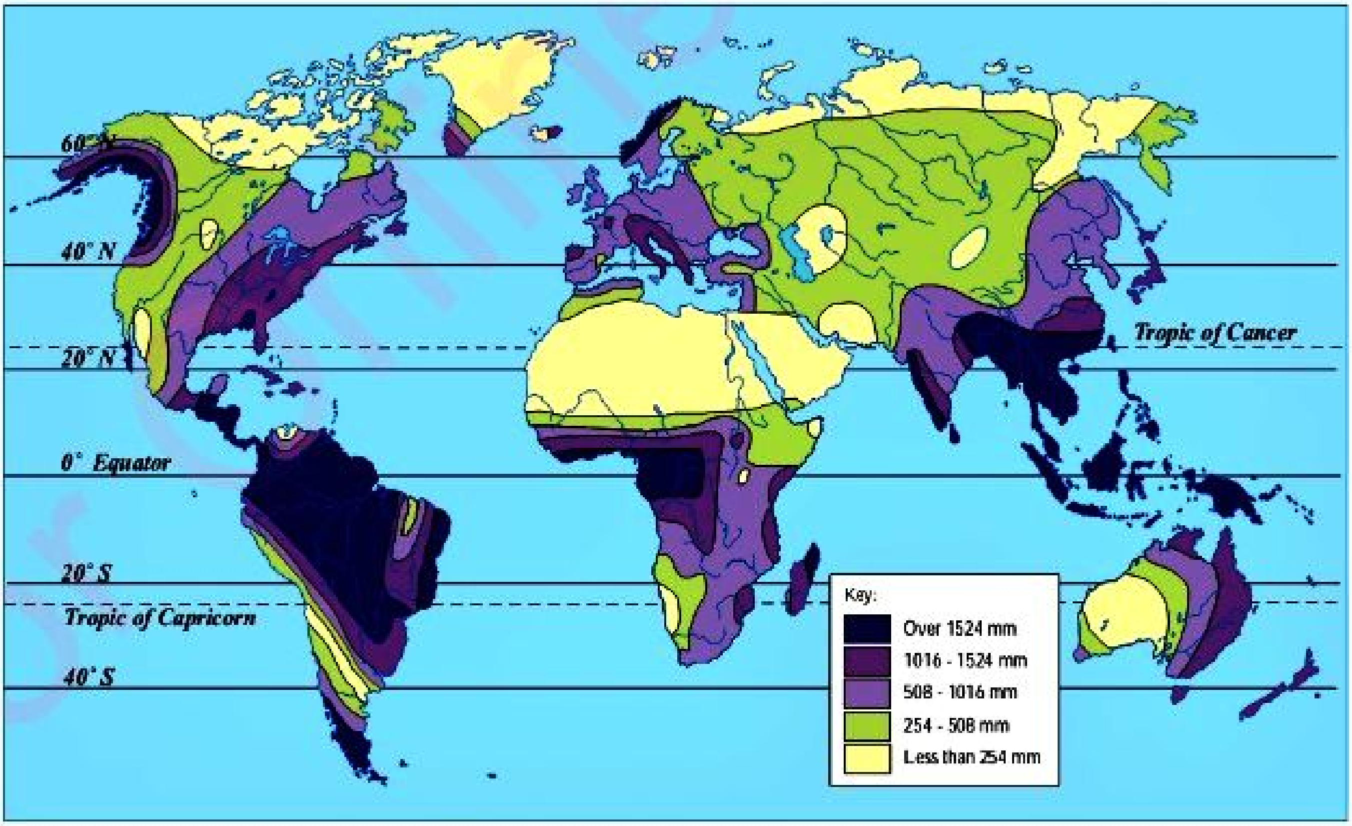


Figure 5.2 World rainfall distribution

Components of a map

A map should have the following basic components:

(a) A *title* that tells what the map is all about e.g. settlement patterns of Dodoma

(b) A *key or legend* is used to interpret the signs and symbols used on the map.

(c) A *margin* or *frame* that bounds the map area

(d) An indication of the *North direction*. This allows the viewer to determine the direction of the map in relation to the true north (direction towards the North Pole).

(e) A *scale* showing the relationship between the distance on the map and that on the ground e.g. 1:50000 or $\frac{1}{50000}$

(f) *Date* of production tells how old the map is, and hence how current the information is e.g. settlement patterns of Dodoma (2018).

(g) *Publisher's* name tells where the map was published and the organisation that prepared it.

Symbols and signs

Information on a map is represented using symbols and signs. These are called the *alphabet of maps*. With the aid of a key, one can interpret or read a given map. Symbols usually look like the features they represent, but signs do not (Figure 5.3(a) and (b)). Most of the symbols are pictorial whereas signs are conventional. A conventional sign is a standard symbol used on a map and explained in the key to show a definite meaning. For example, a dot represents a town or settlement. Signs and symbols are used to improve the reading and interpretation of maps. Various symbols are used to represent features such as buildings, mines, forests, rivers and lakes. Features may be represented using colours of the actual features. For instance, vegetation is represented using green whereas water is represented using blue.

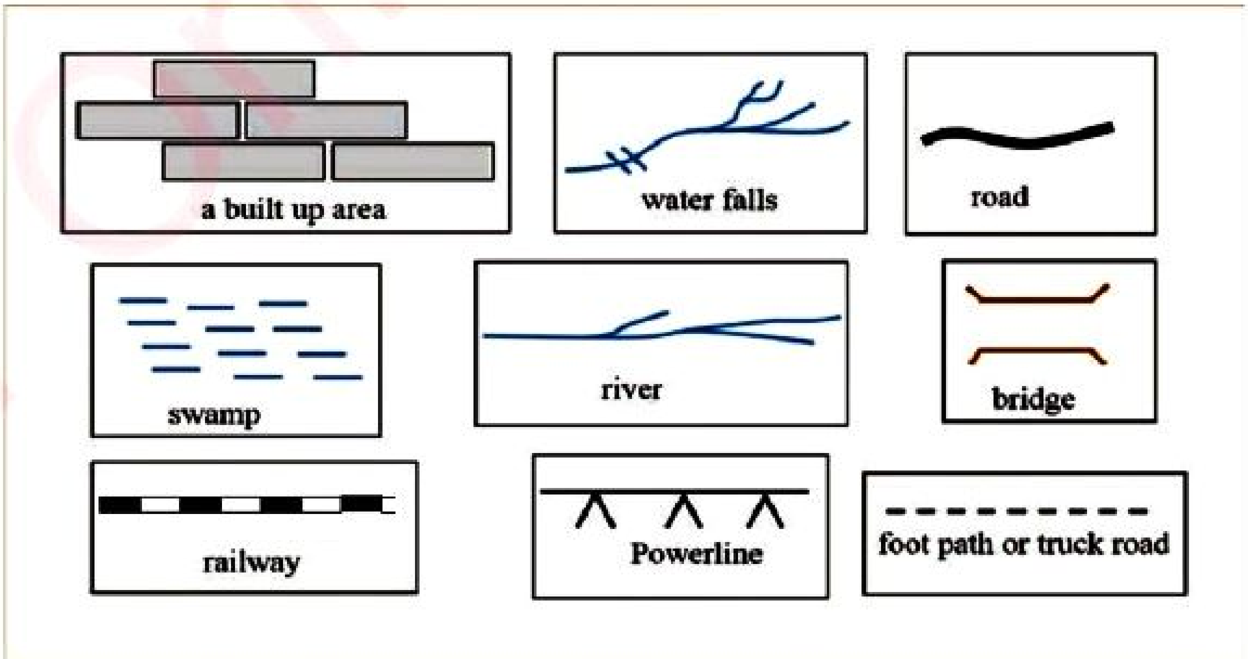


Figure 5.3(a) Some of the symbols used on maps

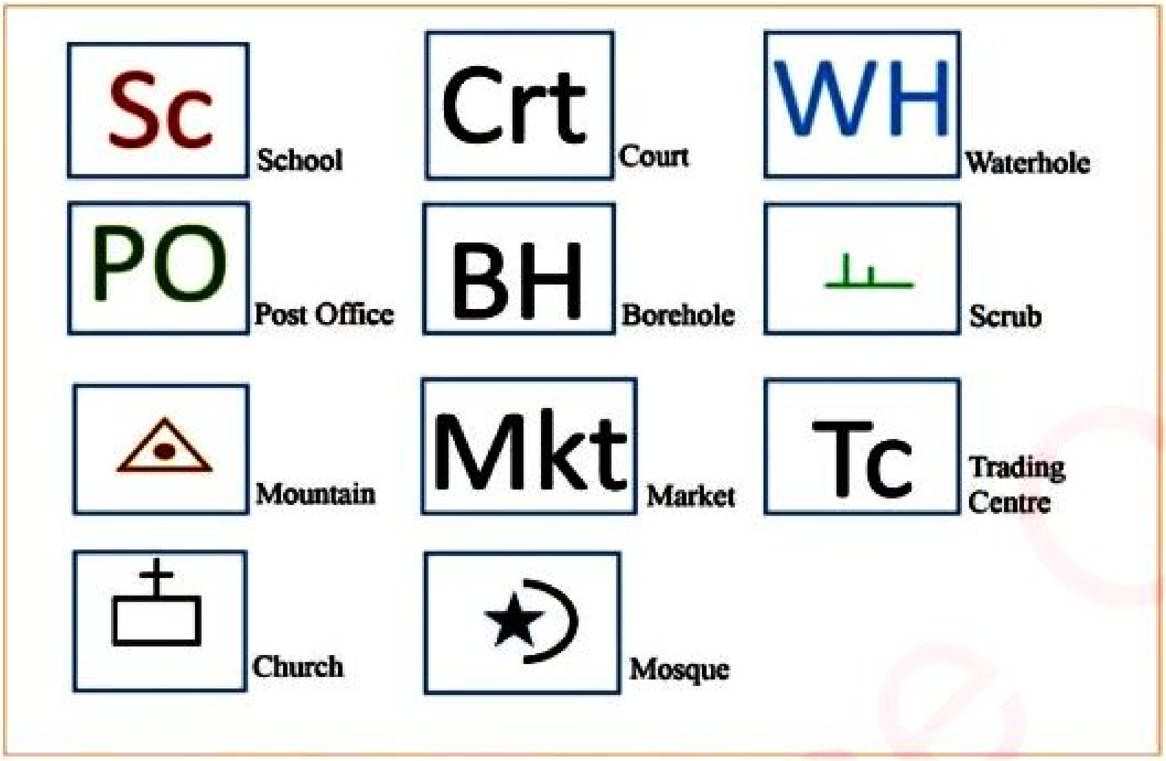


Figure 5.3(b) Some of the signs used on maps

Exercise 5.1

Using any topographical map,

(a) name all components of maps

(b) draw and label signs and symbols used.

Map scale

A scale of a map is the ratio between the distance measured on the map (map distance) and its corresponding actual distance on the ground (actual ground distance). A map scale is calculated using the following formula:

$$\text{Map scale} = \frac{\text{Map distance}}{\text{Actual ground distance}}$$

Imagine if one were to draw a line of 10 metres long in an exercise-book. This would be impossible because the exercise-book is smaller than the length required. One could only draw this line by representing that distance in a known proportion, let us say 1:100. In this case, one centimetre in the exercise-book represents one metre on the ground. Note that the word "represents" and not "equal" is used because the line in the exercise-book is 10 centimetres and not 10 metres. Thus, a 10- metre distance on the ground can be represented by a 10- centimetre line in an exercise-book.

Types of map scales

The size of the area covered helps to determine the scale of a map. Map scales are commonly presented by a representative fraction such as 1:10000. Map scales are grouped into three types: *small-scale*, *medium-scale* and *large-scale.*

Small-scale

A small-scale has a large denominator in its representative fraction. Examples of small-scales include 1:250000, 1:500000, and 1:1000000. When a small-scale is used to draw a map, it produces a small-scale map. Small scale maps are used to represent large ground areas, with few details such as distribution of continents only (see Figure 3.1 in chapter three), major water bodies only (see Figure 3.9 in chapter three), or relief features only (see Figure 3.7 in chapter three). Examples of small-scale maps are maps of countries, continents and the world (Figure 5.4).

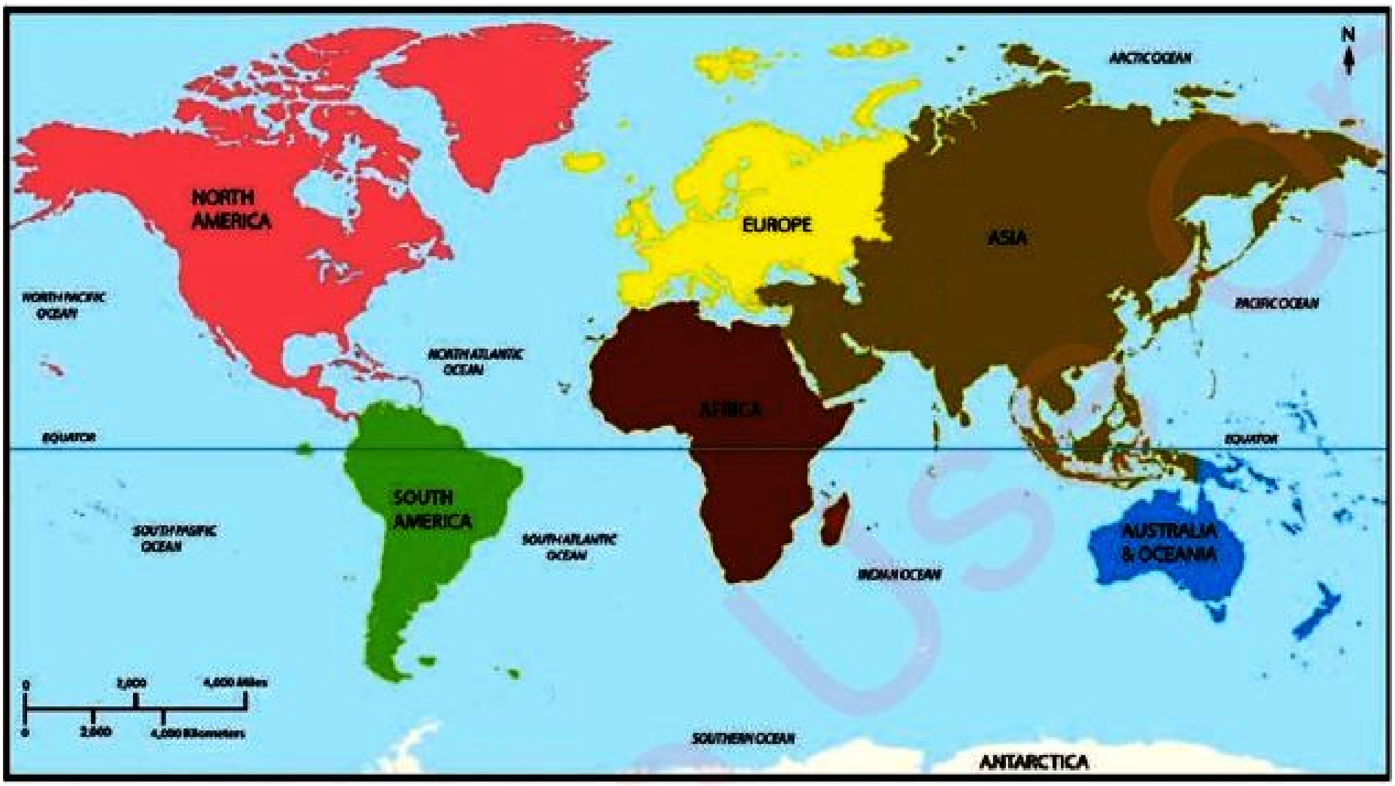


Figure 5.4 Distribution of continents

Medium-scale

A medium-scale has a medium denominator. These are scales of 1:50000, 1: 100000 and 1:125000. Medium-scale maps are used to represent ground areas which are neither too large nor too small. They show a considerable amount of details. Examples of medium-scale maps include maps of districts, regions and cities (Figure 5.5).

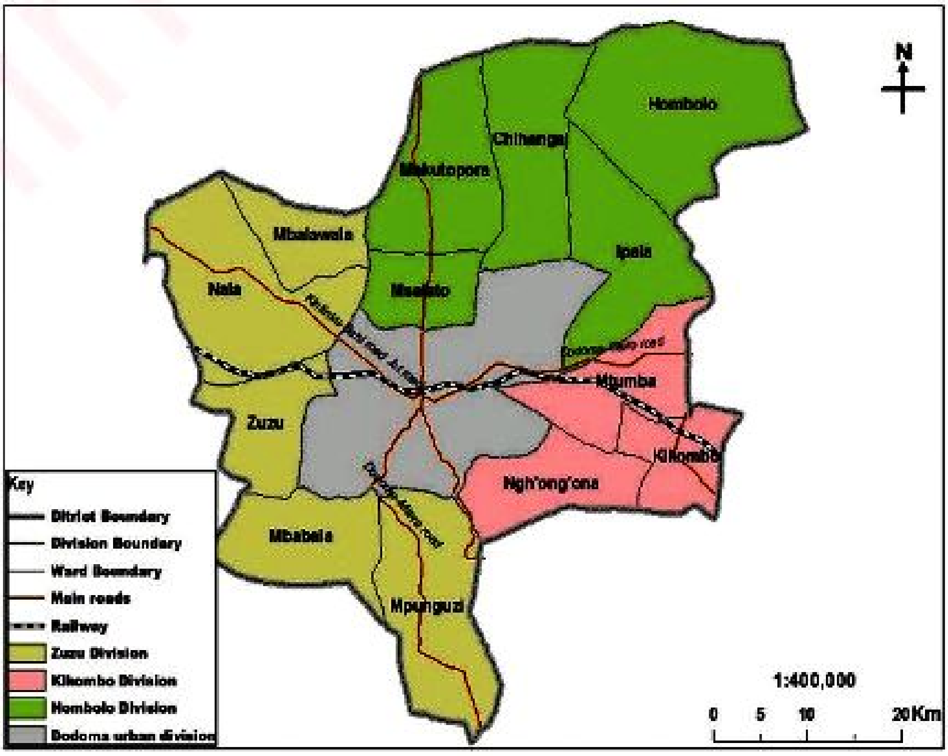
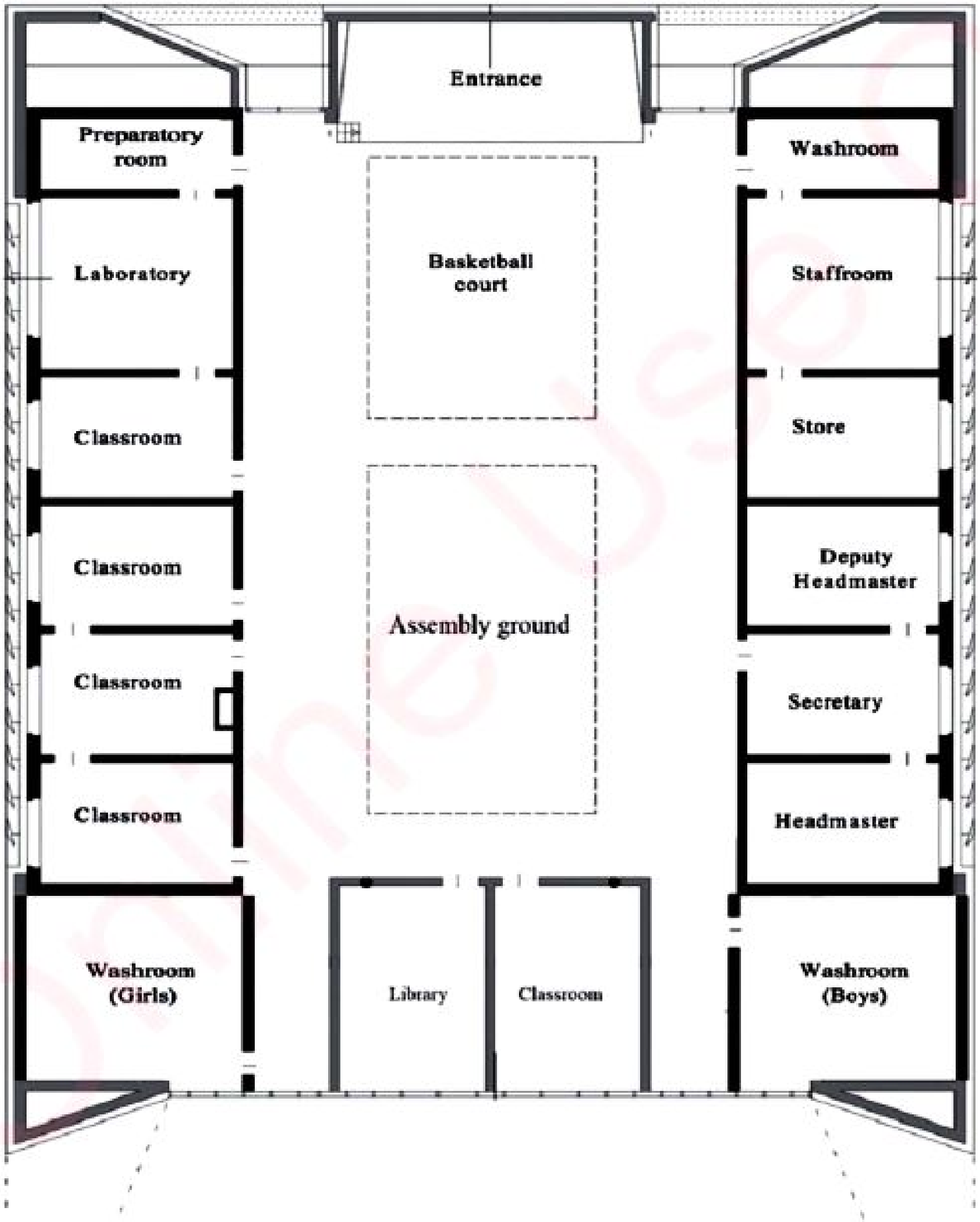


Figure 5.5 Administrative unit of Dodoma district

Large-scale

A large-scale has a small denominator. For example, scales of 1:25000, 1:10000 and 1:5000. Large-scale maps represent small areas and are more detailed. The larger the scale, the more the details provided. Examples of large-scale maps include maps of buildings such as hospitals and schools. Others are farms, estates and villages. A map of a building will have a larger scale than that of a village. It will show all the details including doors, windows and rooms (Figure 5.6).



Scale 1:500

Figure 5.6 A map of a school

Expressing map scales

Map scales are expressed in three ways:

(a) As a *statement:* The scale is presented in a form of a statement. For example, one centimetre on the map represents one hundred metres on the ground.

(b) As a *Representative Fraction (RF):* The scale is presented as a fraction or a ratio such as $\frac{1}{10000}$ whereby 1 is numerator and 10000 is denominator or 1:10000. This means 1 unit on the map represents 10000 units on the ground. These units can be any unit of measurement such as centimetres, metres and kilometres. The unit of measurement used on the map must be the same as the one used on the ground. Therefore, the numerator and the denominator should use the same units of measurements.

(c) As a *linear scale:* This scale is presented using a graduated line which shows measurements of maps representing units on the ground (Figure 5.7). A linear scale is a line with secondary and primary divisions. The secondary divisions indicate the numbers that have values of less than 1 unit such as a kilometre. They are placed on the left-hand side and written in metres (m) as fractions of a kilometre (km). The primary divisions, which are placed on the right-hand side are in kilometres.

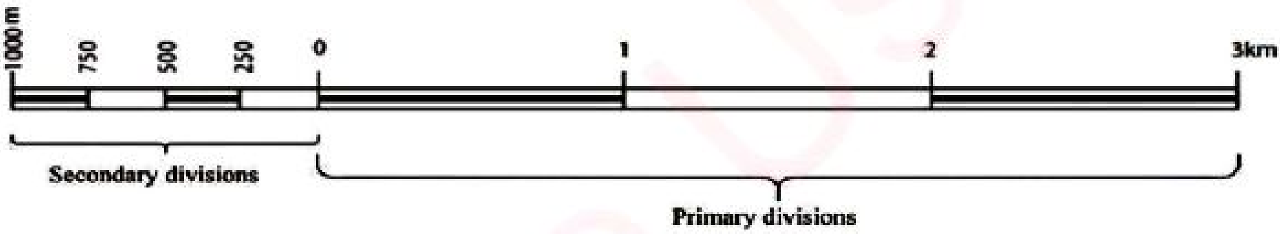


Figure 5.7 A linear scale

Conversion of scales

Scales of maps can be expressed in more than one way. It is even easier to convert a scale from one form into the other. A scale represented as a statement: ie 'one centimetre represents one kilometre' can be converted into a representative fraction. It can also be presented in a linear scale. For example, the statement scale 'one centimetre on a map represents one hundred thousand centimetres on the ground' can be presented in ratio as 1:100000 or fraction. It can also be converted into a linear scale. In this case, one centimetre will represent one kilometre on the linear scale.

Converting a representative fraction scale into a statement scale

Scales in form of Representative Fractions (RF) can also be converted into a statement form. For example, when converting RF of 1:50000 into a statement scales, the procedure will be as follows:

Divide the denominator (50000) by 100000 (actual number of cm in km)

$$\text{Scale} = \frac{\text{Map distance}}{\text{Actual ground distance}}$$

$$\text{Actual ground distance} \frac{50000 \text{ cm}}{100000 \text{ cm}} \times 1 \text{ km}$$

Ground distance = 0.5 km

Therefore, the statement is one centimetre on the map represents half a kilometre on the ground.

Converting representative fraction scale into a linear scale

Scales in form of Representative Fractions (RF) can also be converted into linear scales. For example, to convert 1:50000 into a linear scale follow the following procedures:

(i) Convert the R.F scale into statement scale

(ii) Calculate how many cm will represent 1 km.

Since 1km = 100000 cm

? = 50000 cm

$$= \frac{1\text{km} \times 50000\ \text{cm}}{100000\ \text{cm}}$$

$$= \frac{1}{2}\ \text{km}$$

1 cm to $\frac{1}{2}$ km

or 2 cm to 1 km.

(iii) Draw a straight line and sub-divide it into divisions of two centimetres each. The divisions are primary divisions.

(iv) Sub-divide the first division into secondary divisions (halves or quarters or one-tenths).

(v) Number the primary divisions from 0 rightward, that is 0, 1, 2, 3… and label them in km.

(vi) Number the secondary divisions from 0 leftward, that is, 0, 250, 500, 750 and 1000 and label them in metres.

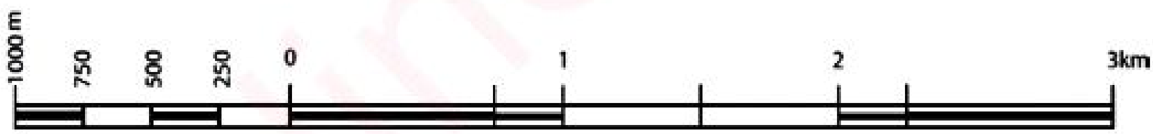


Figure 5.8 A linear scale to measure 2 cm to 1 km

Converting a linear scale into a representative fraction scale

Using a ruler, measure the length of one portion of the linear scale. The result obtained in centimetres will be the map distance. The length expressed in kilometres on the linear scale is the ground distance.

Example, a scale of 2 cm to 1 km, given that:

1 km = 100000 cm

$$\text{Scale} = \frac{\text{Map distance}}{\text{Actual ground distance}}$$

$$\text{Scale} = \frac{2\ \text{cm}}{100000\ \text{cm}}$$

$$\text{Scale} = \frac{1}{50000}\ \text{or}\ 1:50000$$

Exercise 5.2

1. Convert the following statement scale into an RF scale:

   (a) One centimetre to five kilometres

(b) Two centimetres to twenty-five kilometres

2. Present the following representative fraction into a linear scale:

   (a) 1:500 (b) 1:1000 (c) 1:75000

Uses of scale

Maps represent man-made and natural features. Some of the features on the ground are very large and, thus, cannot be drawn in their actual size on a piece of paper or flat wood. Cartographers use scales to draw maps. The scales determine the contents of a given map. For example, large-scale maps are more detailed than small-scale maps. A scale is also used to calculate area and distance on a map.

Differences between small-scale map and large-scale map

(i) A small-scale map represents a large area on the earth's surface whereas a large-scale map represents a small area on the earth's surface.

(ii) A small-scale map shows fewer details on a map whereas a large-scale map shows more details.

(iii) A small-scale map is represented by a large denominator whereas a large-scale map is represented by a small denominator.

Quantitative information on maps

In working with maps, we use numbers to show *distances*, *lengths*, *width* and *heights*. These numbers are known as quantitative map information.

Measurement of distance on maps

To obtain measurements of actual distances on a map, a linear, representative or statement scale given on the map is used. In measuring distances there are two main types: straight distances and distances which are not straight.

Measuring straight distances

Straight distances on a map can be measured using *a piece of paper, a cotton thread, a measuring tape, a ruler* or *a pair of dividers*. Measuring a straight distance on a map using a piece of paper is done as follows:

(i) Draw a straight line which joins two points A and B of the distance to be measured.

Figure 5.9 A straight line joining points A and B

(ii) Take a piece of paper, fold it to form a straight edge. Lay the edge along the line AB and mark the exact length of the line on the edge of the paper, that is, the exact locations of points A and B (Figure 5.10).

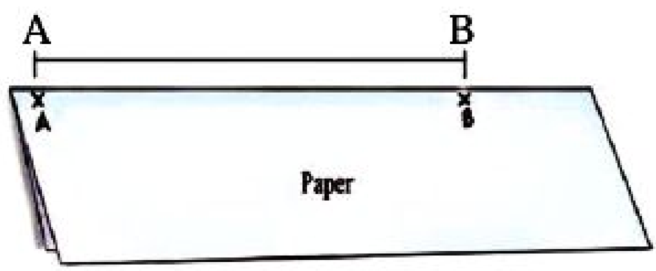


Figure 5.10 Line AB and a folded piece of paper

(iii) Transfer the paper to the linear scale so that the left-hand mark is on 0 (zero). The right-hand mark B falls on 2 km. Alternatively, using a ruler, you can measure the length on the paper from where you started to the last mark on the paper. For instance the distance is 17 centimetres and the scale is 1:50000. Convert the distance obtained on the map (17 cm) into ground distance.

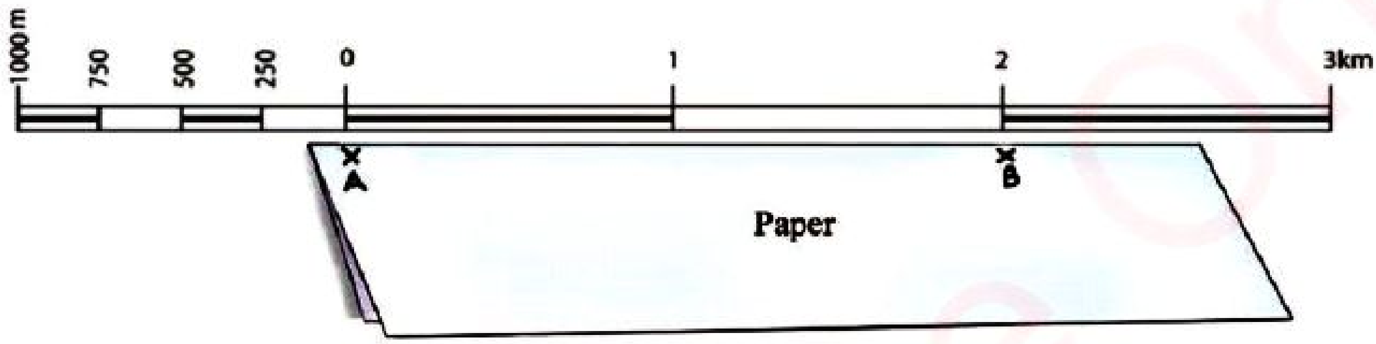


Figure 5.11 A linear scale and a line AB measuring 2 km

Note that 1 cm on the scale represents 0.5 kilometres. Therefore, the distance of the route between A and B is 8.5 kilometres.

Measuring distances which are not straight (curved)

Distance along a river, a road or a railway, which are normally not straight, can be measured using a *pair of dividers*, a *straight piece of paper* and a *thread* or *string*.

Using a pair of dividers

A *pair of dividers* can be used to obtain the distance.

Procedures:

(i) Identify the two points to be measured, for example, points A and B.

(ii) Divide the length to be measured into short, generally straight portions.

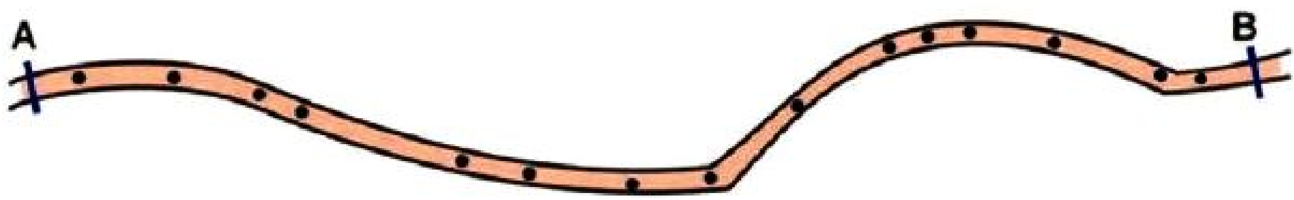


Figure 5.12 A curved length to be measured

(iii) Use a pair of dividers to determine the length of each division, one after another.

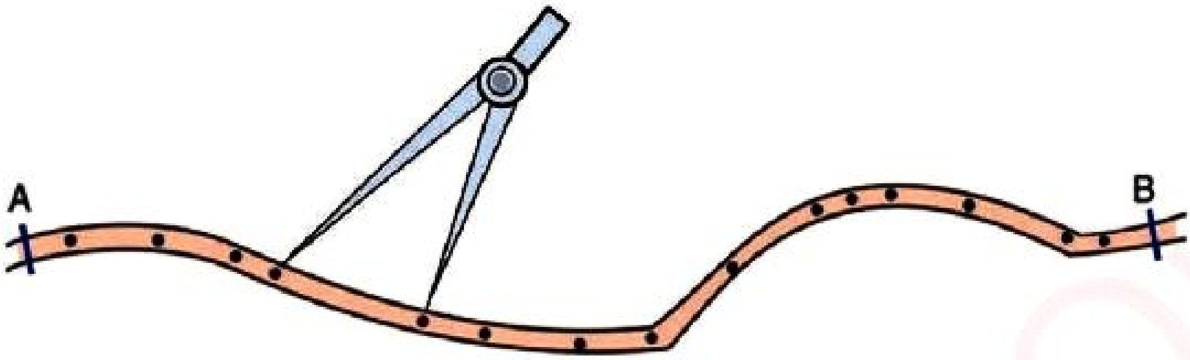


Figure 5.13 A curved length to be measured and a pair of dividers

(iv) Measure the length of each division as determined by the pair of dividers on a ruler and record it on a piece of paper.

Figure 5.14 A ruler and a pair of dividers

(v) Add all the measured distances to obtain the total distance from point A to B.

(vi) Convert the distance obtained into ground distance using the scale of the map.

Using a piece of paper

Another way of measuring distances on a map that are not straight is to use a **piece of paper** with a straight edge. This is done through the following procedures:

(i) Identify the two points to be measured.

(ii) Divide the length to be measured into short, generally straight portions.

(iii) Lay one corner of the straight edge of the paper on point A. Mark with your pencil short straight distances on the paper and on the map repeatedly until you reach point B. (Figure 5.15).

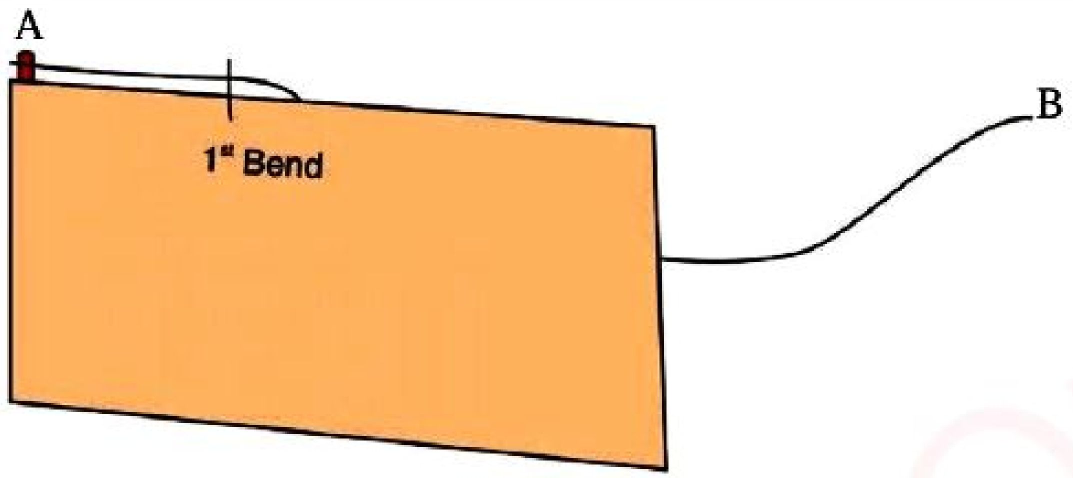


Figure 5.15 A piece of paper with a straight edge

(iv) Remove the marked paper and read the distance straight from point A to B using a ruler.

(v) Then, calculate the actual distance using the RF scale or read the distance straight from the linear scale. If this distance is 20 centimetres and the scale is 1:100000 (1 centimetre to 1 kilometre), then the distance of the route between A and B is 20 kilometres.

Using a cotton thread or string

Sometimes a piece of cotton thread or string is used. The thread is laid along the route following the bends. This can be done using the following procedures:

(i) Mark the two end-points, for example, A and B.

(ii) Mark on the thread or string with ink or a pen.

(iii) Trace the measured line with a thread from point A to B

(iv) Remove the thread or string and read the distance straight from the linear scale.

Measurement of areas on a map

Regular shapes

Different features on maps may appear in various regular shapes, such as rectangles, squares, triangles and circles.

(a) Area of a square

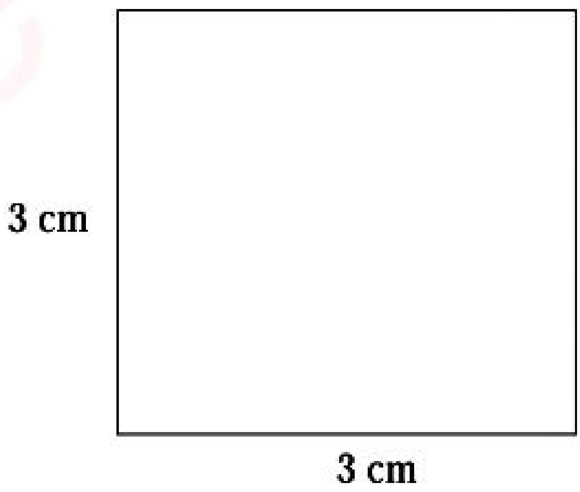


Figure 5.16 A square

Procedures:

(i) Measure the length of the sides of the square (S) (Figure 5.1)

(ii) Find the area by multiplying side by side ($S \times S$).
Therefore, the area on the map $= 3\text{ cm} \times 3\text{ cm} = 9\text{c m}^2$

(iii) Convert the map area into a ground area.

Assuming the scale of the map is 1:50000 (that is, 1cm represents 0.5 km on the ground).

Therefore,

$1\text{ cm} \times 1\text{cm} = 1\text{ cm}^2$ (on the map)

$0.5\text{ km} \times 0.5\text{ km} = 0.25\text{ km}^2$ (on the ground)

that is, 1 cm^2 to 0.25 km^2.

If 1 cm^2 represents 0.25 km^2,

9 cm^2 will represents how many km^2?

By cross-multiplication:

$$= \frac{9\text{cm}^2 \times 0.25\text{ km}^2}{1\text{cm}^2}$$

$$= 2.25\text{ km}^2$$

Therefore, the area on the ground is **2.25 km^2.**

(b) Area of a rectangle

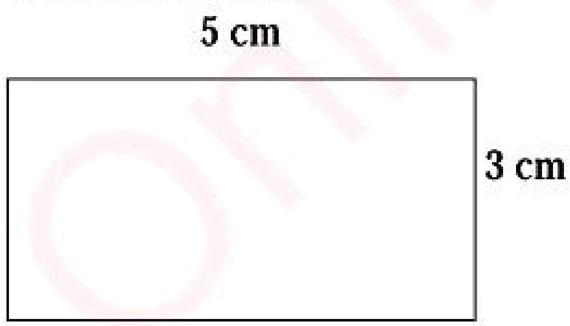


Figure 5.17 A rectangle

Procedures:

(i) Measure the length and width of the rectangle.

(ii) Use the formula to find the area of a rectangle.

(iii) Convert the map area into a ground area.

For example, using Figure 5.17, measure the area of rectangle.

Area (A) = L × W

where L is length and W is width.

Area on a map = 5 cm × 3 cm

$= 15\text{ cm}^2$

Assuming the scale of a map is 1:50000, conversion of the area of the map into an area on the ground is done as follows:

If 1 cm^2 represents 0.25 km^2

15 cm^2 will represents how many km^2?

By cross-multiplication:

$$\frac{15\text{ cm}^2 \times 0.25\text{ km}^2}{1\text{ cm}^2}$$

$$= 3.75\text{ km}^2$$

Therefore, the area on the ground is **3.75 km^2**

(c) Area of a triangle

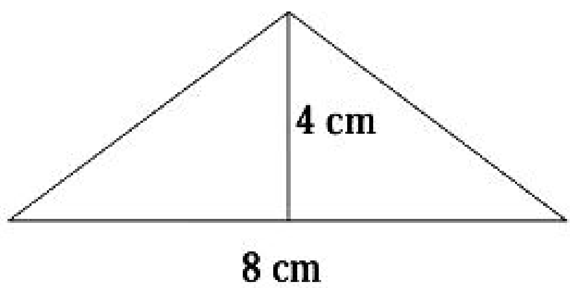


Figure 5.18 A triangle

Procedures

(i) Measure the length of the base of the triangle and convert it into ground distance.

(ii) Measure the length of the perpendicular height from the base to the apex, and convert it into ground distance.

(iii) Use the formula to find the area of a triangle.

For example, find an area of a triangle using **Figure 5.18**

$$\text{Area (A)} = \frac{1}{2}\text{bh}$$

Whereb = base,h = height

$$= \frac{1}{2} \text{x8 cm x4 cm}$$

$$= 16\,\text{cm}^2$$

Hence, the area of the triangle on the map = 16 cm^2

If the scale of a map is 1:100000 (1cm represents 1km) Then, 8 cm represents 8 km and 4 cm represents 4 km.

Therefore, the area of the triangle on the ground will be 16 km^2.

Irregular shapes

There are three ways of determining areas of irregular shapes on maps, namely; square or tracing, construction of geometrical figures and stripping methods.

(a) Square or tracing method

Procedures (see Figure 5.19)

(i) Trace the outline of the area on a graph paper.

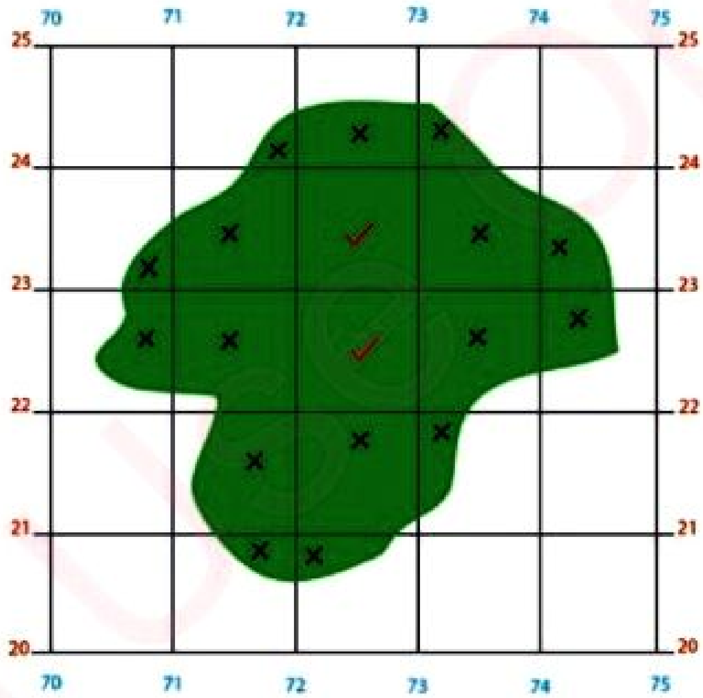
(ii) Using a sharp pencil, trace the outline of the figure whose area you want to determine.

(iii) Count all the complete squares.

(iv) Count all the incomplete squares, and then divide the resulting amount by 2 to get complete squares.

(v) Add all the complete squares to get the total number of complete squares.

(vi) Measure the length of one side of the square.



Key:

✓ = *Complete square,*

✗ = *Incomplete square*

Figure 5.19 Square method for an irregular shape

Solution

(i) According to the irregular shape provided, the number of complete squares = 2

(ii) Number of incomplete squares

$$= \frac{16}{2} = 8$$

(iii) Total number of squares = Full + Incomplete squares

2 + 8 = 10

Given

Map scale: 1:50000 that is, 2 cm represents 1 km. The area of a single square on the map is calculated as $2\ cm \times 2\ cm = 4\ cm^2$

Calculate an area of a corresponding square on the ground as $1\ km \times 1\ km = 1\ km^2$. Note that 2 cm represents 1km. Therefore, $4\ cm^2$ represents $1\ km^2$, which means that 1 square represents $1\ km^2$.

The number of complete squares in the figure = 2, whereas the number of incomplete squares = 16

The area on the ground is, therefore, calculated as:

Area =

$$\left(\text{complete sqares} + \frac{\text{incomplete squares}}{2}\right)$$

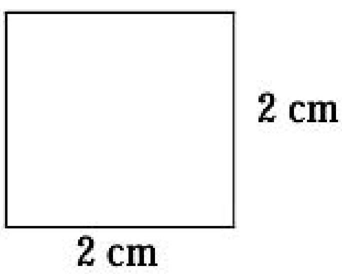
$\times 1\ km^2$

Map scale 1:50000

(iv) Convert the R.F scale into statement scale

i.e. 1:50000 becomes $1cm = \frac{1}{2}$ or

2 cm = 1km



Area= L x W = L x L

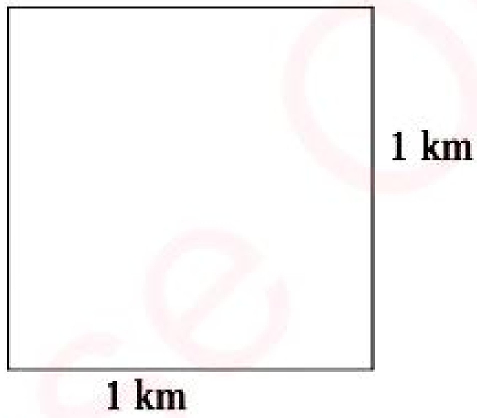
(v) Find the area of one square using the map scale provided.

If; $1\ cm = \frac{1}{2}\ km$

2 cm =?

2 cm = 1 km

Area $= L^2$



Area=1km x 1km

Area $= 1 km^2$

From 1square $= 1km^2$

10 squares =?

$$\frac{10\ \text{squares} \times 1\ km^2}{1\ \text{square}}$$

$= 10\ km^2$

The area of irregular shape is $10\ km^2$

(b) Construction of geometrical figures

The area is divided into geometrical figures whose area can be calculated by using the formulae for calculating areas of squares, rectangles and triangles or a combination of two or three geometrical shapes (Figure 5.20).

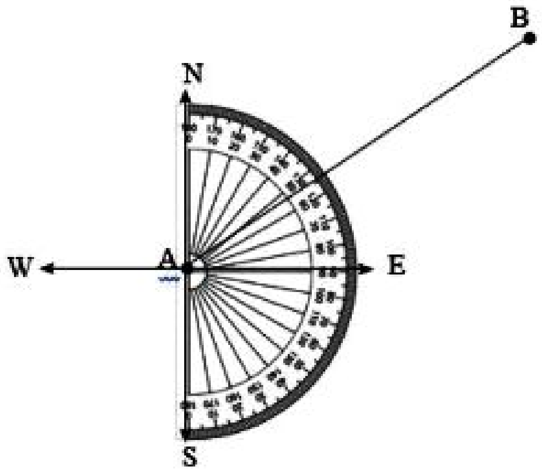


Figure 5.25 Measuring an angle by using a protractor

Point B bears 055° from A and lies in the North east.

Activity 5.3

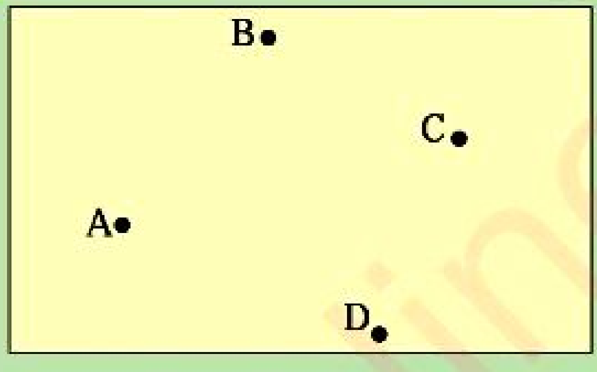


Figure X

From Figure X, find the bearing of the following points:

(i) C from D (ii) D from C

(iii) B from A (iv) A from B

Direction

Direction is used to determine the position of a place. Direction is determined by a horizontal angular measurement at a point. The main directions or cardinal points are *North, East, South* and *West* (Figure 5.26). These cardinal points can be divided into eight (Figure 5.27) and sixteen (Figure 5.28) compass directions.

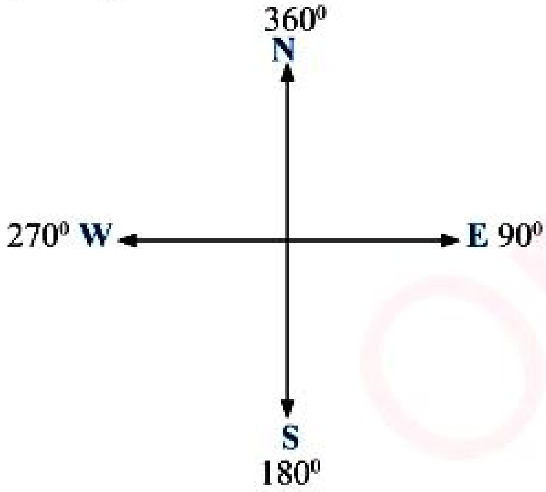


Figure 5.26 Cardinal points of a compass

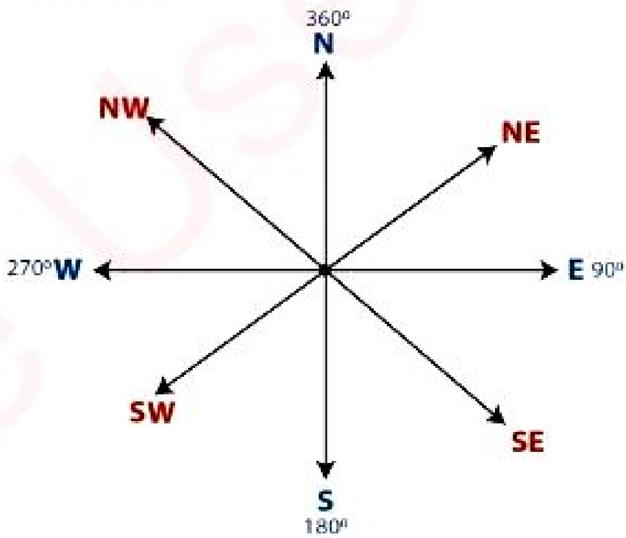


Figure 5.27 Eight compass directions

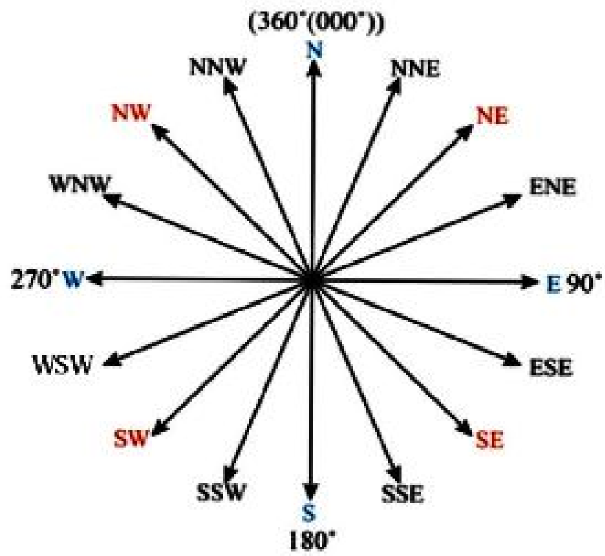


Figure 5.28 Sixteen compass directions

The North direction

The North direction on a map is indicated in three ways. These are *Magnetic North*, *True North* and *Grid North* (Figure 5.29).

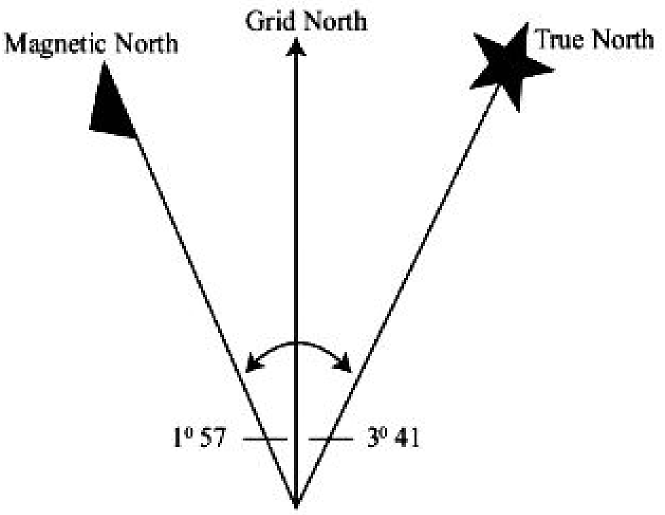


Figure 5.29 North direction

Magnetic North

Magnetic North is determined by using an instrument called a *compass*. The compass has a suspended magnetic needle which swings freely and points to the North when it settles. The direction to which the compass needle points is called the Magnetic North (Figure 5.30).

Figure 5.30 A Compass

The True North

The True North is the direction towards the *North Pole* from any place on the earth's surface. The earth's axis always points to the northern star over the North Pole. The North Pole is, therefore, used as a reference point for the True North.

Grid North

The Grid North is shown by vertical lines (Figure 5.31). It is a straight up arrow pointing North on the map. Sometimes arrows are drawn on a map to show all three types of norths. When reading directions on maps, the True North is usually used.

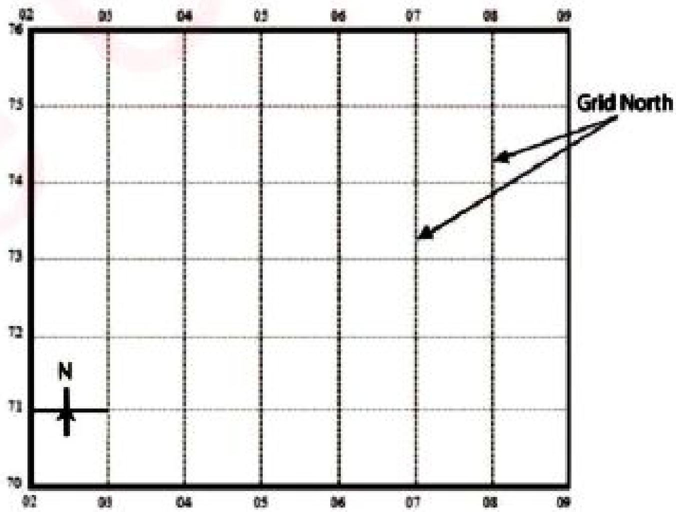


Figure 5.31 Grid lines showing the north direction

Orientation

Orientation is the relationship between the direction on the map and the corresponding compass direction in reality. A map represents the real world. By orienting a map, you are positioning it so that its North is actually pointing northwards.

the third number, 4 refers to the exact position of point B.

The Northing reading is 424 where the first two numbers 4 and 2 refer to the main Northing reference whereas the third number 4 is the exact position where point B is located. The next step is to combine Eastings and Northings. Therefore, the grid reference for point B is 324424. Always state the Eastings before the Northings.

Uses of maps

The use of maps depends on the type of map. All the maps serve the same purpose of telling you where something is located in relation to its surroundings. The main uses of maps are as follows:

(i) Maps are used to show the distribution of various phenomena such as climate, population, minerals, crops and vegetation of an area.

(ii) Land planners and surveyors use maps in planning and construction of roads, railway lines, and airports as well as the location of farms and settlements.

(iii) Geologists use maps for geological surveys and mineral mapping.

(iv) Maps are used in military activities and warfare.

(v) Maps are also used to provide information to pilots and captains in aviation and navigation.

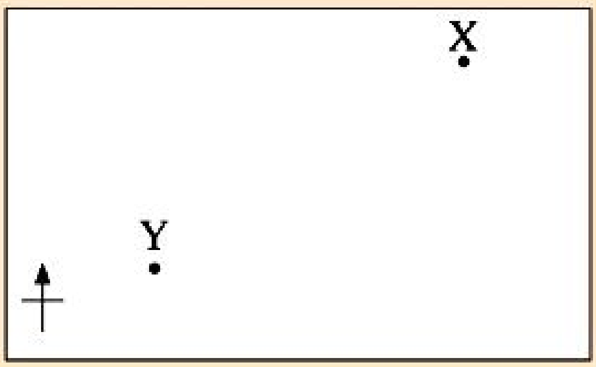
(vi) Travellers use maps to locate and reach the intended destinations.

(vii) Maps are used as legal documents to show the ownership of land, houses and their boundaries.

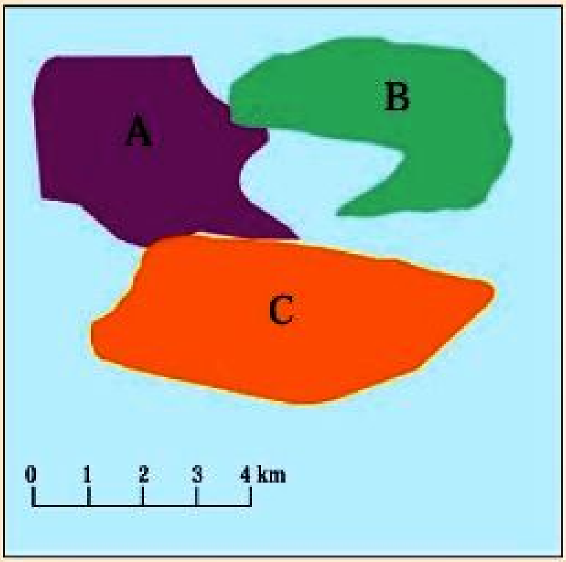
Exercise 5.3

Follow the instructions provided to answer the questions that follow:

1. Using the map scale of 1:50000 calculate the distance of
   (a) Road with 20 cm on the map
   (b) Railway with 10 cm on the map
2. Convert the following representative fraction scale into statement scale:
   (a) 1:100000
   (b) 1:50000
3. Use the map of Tanzania in the Atlas to determine:
   (a) The road distance between Dar es Salaam and Morogoro
   (b) The railway distance between Dar es Salaam and Kigoma
4. From the topographical map given, name any five components of the map.
5. What compass bearing is given for the following compass directions?
   (a) ESE (b) WNW (c) NNW
6. State the compass direction for each of the following compass bearings:
   (a) 280° (b) 135° (c) 45°
7. Using dots Y and X given in the box find the bearing of place Y from place X.



8. Study the irregular figures given and find the area for figures A, B and C in square kilometres.



9. Find the compass bearing of S from R as given below.

10. Describe the main procedures followed in calculating areas with irregular features.

General Exercise

Answer the following questions:

1. For each of the item (i)-(x), choose the correct answer and circle its letter from the alternatives provided:

(i) The air around the earth is known as:
   (a) Atmosphere (b) Climate
   (c) Weather (d) Wind
   (e) Weather and wind

(ii) Physical Geography deals with:
   (a) Environment that includes settlements and economic activities
   (b) Trade and business
   (c) The study of the earth's natural features
   (d) Driving and teaching profession
   (e) Man-made features

(iii) Latitude 0° is known as:
   (a) Equator
   (b) Greenwich meridian
   (c) Tropic of Cancer (d) Tropic of Capricorn
   (e) Arctic circle

(iv) The condition of the atmosphere over a short period is:
   (a) Climate
   (b) Meteorology
   (c) Weather
   (d) Precipitation
   (e) Wind

(v) Which of the following items is essential in measuring distance?
   (a) Compass
   (b) Key
   (c) Frame
   (d) Title
   (e) Scale

3. Match each statement in Column A with its corresponding item in Column B:

Column A	Column B
(i) A piece of land almost surrounded by water or projecting out into water body	(a) Maximum thermometer (b) Minimum thermometer (c) Large scale
(ii) Joins places with the same amount of temperature	(d) Small scale (e) Hygrometer (f) Anemometer
(iii) Used to represent large ground areas and they show few details	(g) Islands (h) Ocean trenches
(iv) The furthest position from the sun in the orbit of the earth	(i) Isotherms (j) Isohyets (k) Aphelion
(v) A tract of land entering into a body of water	(l) Perihelion (m) Great circles
(vi) All meridians and the Equator	(n) International Date Line
(vii) The ocean bordering Africa to the East	(o) Peninsula (p) Cape
(viii) Extensive high-altitude areas with more or less uniform summit levels	(q) Indian ocean (r) Atlantic Ocean (s) Plateau
(ix) Volcanic mountains that still experience periodic eruption	(t) Plains (u) Active volcanoes
(x) Measurement of humidity	(v) Extinct volcanoes

4. Giving three reasons, explain why it is important to study Geography.

5. State two differences between minimum and maximum thermometer.

6. List any four factors that influence climate of an area.

7. (a) Define the term "scale".

   (b) Convert the following statement scales into RF scale:

   (i) One centimetre represents two-and-a-half kilometres on the ground

   (ii) One centimetre represents four kilometres on the ground

   (c) Convert the following RF scales into statement scales:

   (i) 1:450000

   (ii) 1:200000

8. If it is 10:00 am along meridian 40°E, what will be the time along the following meridians?

   (a) 55°E

   (b) 10°W

9. Differentiate between:

   (a) Latitude and Longitude

   (b) Block mountains and fold mountains

10. Describe the formation of cyclonic rainfall.

11. Define the following geographical terms:
   (a) Atmospheric pressure
   (b) Humidity
   (c) Wind
   (d) Sea breeze

12. Write short notes on the following geographical terms:
   (a) Map scale
   (b) Medium-scale
   (c) Large-scale
   (d) Small-scale

13. Study carefully the temperature and rainfall data given for region X in the table below and then answer the questions that follow:

Month	Temperature (°C)	Rainfall (mm)
J	22	8
F	23	8
M	22	17
A	19	43
M	16	124
J	13	167
J	12	162
A	13	142
S	14	83
O	16	53
N	18	20
D	22	15

   (a) Which is the hottest month?
   (b) Which is the coldest month?
   (c) Calculate the mean annual temperature of region X.
   (d) Calculate the annual range of temperature of region X.
   (e) Calculate the mean annual rainfall of region X.

14. Read carefully the following statements and write **T** if the statement is TRUE and **F** if the statement is FALSE
   (a) The word 'sol' comes from a Greek word 'sun'.
   (b) All planets revolve around the sun.
   (c) The Greek word "graphien" means the earth.
   (d) Penumbra refers to the part of the shadow in which the light source is completely blocked.
   (e) The land occupies about 71 percent of the earth's surface.
   (f) The Indian Ocean is larger than the Pacific Ocean.
   (g) Block mountains are also known as horsts.
   (h) A Stevenson screen is not an essential component of a weather station.
   (i) Ocean current is not one of the factors affecting rainfall.
   (j) Lapse rate is the rate at which air temperature falls with increasing altitude.

15. For each of the item (i)-(x) choose and circle the correct answer from the given alternatives.
   (i) The period when the sun is overhead at the equator is called

(a) Summer (b) Solstice
(c) Winter (d) Equinox
(e) Eclipse

(ii) The following pairs of weather elements are correct except:
(a) Atmospheric pressure and barometer
(b) Humidity and anemometer
(c) Rainfall and rain gauge
(d) Wind direction and wind vane
(e) Sunshine and Campbell-Stokes sunshine recorder

(iii) Some mountains are formed as a result of weathering and erosion processes. Such mountains are called:
(a) Horst
(b) Fold mountains
(c) Mesas
(d) Volcanoes
(e) Residual mountains

(iv) Which of the following instruments is used to measure air pressure?
(a) Hygrometer
(b) Barometer
(c) Wind vane

(v) ……………… is the only planet that has been proven to sustain life.
(a) The Earth
(b) The Neptune
(c) The Uranus
(d) The Venus
(e) The Mars

(vi) Africa is bordered by the…………………..to the West.
(a) Mediterranean Sea
(b) Atlantic Ocean
(c) Pacific Ocean
(d) Indian Ocean
(e) Southern Ocean

(vii) An example of a volcanic mountain in the world is:
(a) Vesuvius in Italy
(b) Himalaya in Asia
(c) The Cape Ranges in South Africa
(d) Mount Sinai in Middle East
(e) Usambara in Tanzania

(viii) A raised part of the ocean floor is called:
(a) Ocean plain
(b) Ridge
(c) Continental shelf
(d) Continental slope
(e) Trench

(ix) ………refers to the deposition of moisture or frozen water from the atmosphere.
(a) Hail
(b) Precipitation
(c) Sleet
(d) Snow
(e) Rain

(x) The side of the mountain facing the direction of the winds is known as:
(a) Leeward side
(b) Windward side
(c) Easting
(d) Northing
(e) Bearing

Glossary

Altitude Height of a point above mean sea level measured vertically

Anemometer Instrument for measuring wind speed

Autumn Season of the year, which comes after summer, when leaves fall from trees. In the northern hemisphere it occurs from September to November, and in the southern hemisphere from March to May

Aphelion Point in the orbit of a planet, asteroid, or comet which is the furthest from the sun

Atmosphere Layer of gases surrounding the earth or another planet

Atmospheric pressure Pressure exerted by the weight of the atmosphere, which at sea level, has a mean value of 760 mmHg

Axis Imaginary line about which a body rotates

Barometer Instrument for measuring atmospheric pressure, used especially in weather forecasting

Bearing The direction or position of something, or the direction of movement, relative to a fixed point. It is typically measured in degrees, usually with the magnetic north as zero

Cartography Science or practice of drawing maps

Circumnavigation Sailing all the way around the world

Climate Average weather conditions prevailing in an area over a long period of time

Compass Instrument containing a magnetized pointer that shows the direction of the magnetic north and bearings from it

Condensation Formation of water droplets or ice crystals from water vapour

Crater Bowl-shaped cavity in the ground or on the top of mountain caused by volcanic eruption or meteorite impact

Dew Tiny drops of water that form on cool surfaces at night

Dewcell Instrument used for determining the dew point

Environment Surroundings or conditions in which living organisms operate

Equator: Zero (0°) latitude,dividing the earth into two equal halves

Equinox Day and night of equal length

Erosion Removal and transport of weathered materials by water, wind, ice, or other natural agents

Fog Cloud at ground level that reduces visibility, usually less than 1km

Gravitational force Force that pulls heavenly bodies towards each other or towards the source body

Great circle Circle on the surface of a sphere that lies in a plane passing through the sphere's centre

Greenwich meridian Prime meridian 0^0 running from north to south dividing the earth into two equal parts

Gulf Part of the ocean that penetrates the land

Hemisphere One half of the earth as divided by the equator

Heritage Resources belonging to a culture of a particular society, such as traditions, languages, historical sites, or buildings that were created in the past and are still valued

Humidity Amount of water vapour in the atmosphere

Hygrothermograph Instrument used to measure both relative humidity and temperature simultaneously onto a single chart

Isotherms Lines on a weather map connecting points having the same temperature

Lapse rate Rate at which air temperature falls with increasing altitude

Map Representation of a whole or part of an area of the earth's surface as viewed vertically from above on a flat surface

Meniscus Curved upper surface of a liquid in a vessel

Meridians Imaginary lines which run from North Pole to South Pole east or west of the Greenwich meridian (0°)

Meteorite Solid body from space that partially survives entry into an atmosphere and lands on a planetary surface

Meteor Small body of matter from outer space that enters the Earth's atmosphere

Mist Tiny water droplets suspended in the air

Moisture Water or other liquid diffused in a small quantity as vapour, within a solid, or condensed on a surface

Navigation A science of determing position and direction of movement from one place to another

Orbit Elliptical path through which heavenly bodies revolve around the sun

Peninsula	Piece of land surrounded by water on majority of its borders
Perihelion	Point in the orbit of a planet, asteroid, or comet at which it is closest to the sun
Plateau	Area of relatively flat topped high elevated land
Precipitation	Deposition of moisture from the atmosphere on the earth's surface
Rain gauge	An instrument used in measuring rainfall
Relief	Features of the landscape associated with changing heights from the surrounding
Ridge	Long narrow elevation of land, chain of hills or mountains
Rotation	Spinning movement of a body on its axis
Run-off	Draining away of water from the land surface
Satellite	Natural or artificial celestial body that moves or circles a bigger object
Solar energy	Radiant energy emitted from the sun
Solar system	Arrangement of all celestial bodies in relation to the position of the sun
Solstice	Period of the year in which the sun is vertically overhead (sun stand-still)
Spring	The season of the year between winter and summer in which temperature rise gradually
Strait	Narrow passage of water connecting two seas or two large water bodies
Summer	Warmest season of the year in the temperate regions
Temperature	Degree of hotness or coldness of a body or place

Thermograph Instrument that produces a trace or image representing a recording of the varying temperature over an area during a period of time.

Valley Low area of land between hills or mountains.

Weather Condition of the atmosphere at a given place and time.

Weather forecasting Prediction of the state of the atmosphere.

Weather station Observation post where weather conditions and meteorological aspects are recorded

Wind Moving air from high pressure to low pressure areas.

Winter Coldest season of the year in temperate regions