Biology

BIOLOGICAL CLASSIFICATION OF ORGANISMS

There is a great diversity of living organisms in nature and to understand this diversity, there is need to classify the organisms.

Classification is the grouping together of organisms in defined groups basing on their similar features/characteristics. During classification, organisms are put into different groups according to their similarities and differences. When organisms have similar features, they are placed together in one group and such a group is called a **taxon.**

The branch of science that deals with classification of organisms is called **taxonomy**, i.e Taxonomy is defined as the science of classification and naming of organisms.

Nomenclature is the naming of organisms (giving of names to organisms). **Systematics** is the study of evolutionary relationships among organisms.

BINOMIAL NOMENCLATURE

This is a system of naming organisms in which the organism is given two Latin names hence the word binomial. The organism is given two names, the first one for the genus called the **generic name** and the second one for the species called **specific name.** The first name (generic name) starts with a capital letter while the second name (specific name) starts with a small letter. The two names are written separate from each other and underlined separately.

SYSTEMS OF CLASSIFICATION

Artificial classification: this is based on a limited range of distinguishing characteristics of organisms (a few or a single easily observable characteristic) for simplicity and convenience. Animals in this system were into two groups basing on the flying ability and plants were classified on the basis of height e.g herbs, shrubs, trees. This system of classification was not convincing. It does not reflect any natural relationship existing among organisms. It leads to grouping unrelated organisms under one group.

Natural classification: this is based on as many characteristics as possible. It considers the significance of characteristics rather than convenience. It considers characteristics basing on morphology, embryology, physiology, biochemistry, cytology, behavior etc.

Phylogenetic classification: this is based on evolutionary history (phylogeny) of organisms. Organisms belonging to the same group are believed to share a common ancestor.

Phenetic classification: this is based only on observable characteristics of organisms regardless of their phylogeny or evolutionary relationships. It only looks at observable similarities and differences among organisms without looking into their evolution.

NOTE: Modern classification is mostly natural and phylogenetic.

THE TAXONOMIC HIERARCHY.

This is the descending order in size of taxonomic groups. Each taxonomic group is called a taxon (plural taxa). Organisms are put in taxonomic groups basing on the similarities and differences, with similar organisms being put in the same group.

The different taxonomic groups from the biggest to the smallest are;

- Kingdom

- Phylum
- Class
- Order
- Family genus Specie

A species is a group of organisms which can interbreed freely to produce viable or fertile offsprings.

THE FIVE KINGDOMS

- Prokaryotae
- Protoctista
- Fungi
- Plantae
- Animalia

VIRUSES

Viruses are not classified in any kingdom of living things because they a not truly living things. Viruses are the smallest living units known (they are the smallest living things with a size of 20-300nm in diameter. They have a simple structure consisting of a small piece of nucleic acid which in most viruses is surrounded by a protein or a lipoprotein. Viruses contain either DNA or RNA but not both. They are obligate endo-parasites living only parasitically inside other cells (host cells). They are highly host specific (each virus infects a specific host). Viruses have both living and non-living characteristics.

The living characteristics of viruses include;

- They possess genetic material and can transmit their characters to the next generation
- They can mutate and hence evolve
- They carry out protein synthesis in host cells
- They are capable self-replication when inside host cells
- They can transmit characteristics to the next generation

The non-living characteristics of viruses include;

- They lack a cellular structure (are acellular)
- They can be crystallised
- They lack enzyme systems
- They are incapable of metabolism on their own

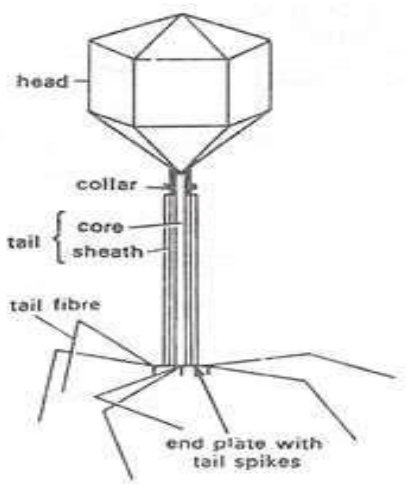
Generalised structure of a virus

All viruses consist of a protein coating called capsid. The capsid is made of subunits called capsomeres. The capsid is the protective coat and surrounds the core.

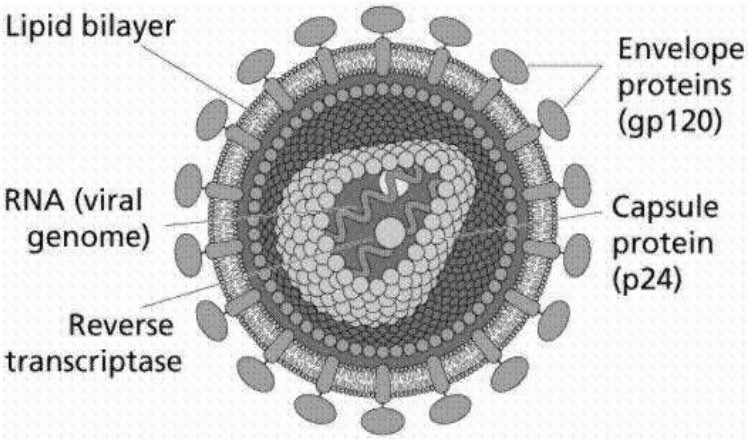
The core is the inner region and consists of the nucleic acid (DNA or RNA). The nucleic acid may be single stranded or double stranded. The nucleic acid may be in spiral form or helix form. In some viruses, the protein coat may be surrounded by an envelope mainly consisting of lipids.

Viruses which infect bacteria are called **bacteriophages**

Structure of a bacteriophage



Structure of HIV virus



HIV is an RNA virus (it has RNA as the genetic material). The RNA is single stranded and is surrounded by a protein capsid enclosed in a lipid envelope. During replication, the viral RNA is first converted into viral DNA by an enzyme **reverse transcriptase**, i.e there is reverse transcription hence **retrovirus.** The viral DNA is then incorporated into the host genome and replicated along with host cell replication. The viral genome is transcribed and translated along the host cell genome to make viral proteins which assemble and make more copies of the virus.

Other examples of animal viruses include; hepatitis viruses, measles virus, polio virus, small pox virus, rabies virus, foot and mouth disease virus, influenza virus, corona virus etc.

Examples of plant viruses include; Cassava mosaic virus, tobacco mosaic virus,

KINGDOM MONERA

These are Prokaryotic organisms whose genetic material is not bound by a nuclear membrane. All members are unicellular. They include bacteria and cyanobacteria.

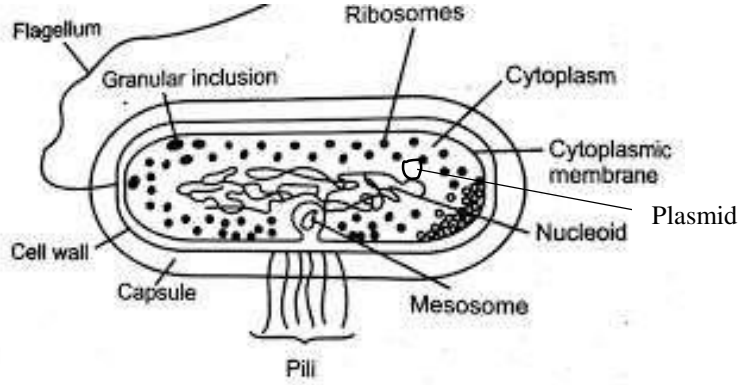
Characteristics

- They are unicellular
- They are prokaryotes
- They have a rigid cell wall
- They are both heterotrophs and autotrophs

BACTERIA

They are the smallest unicellular organisms and they are the most abundant. They may be found living as single organisms or in colonies.

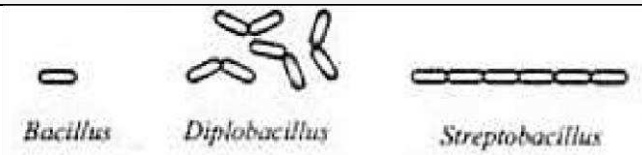
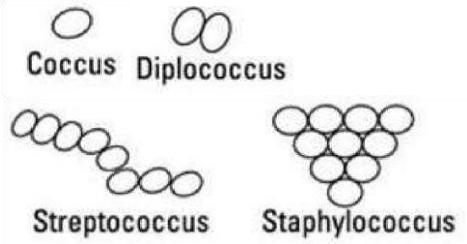
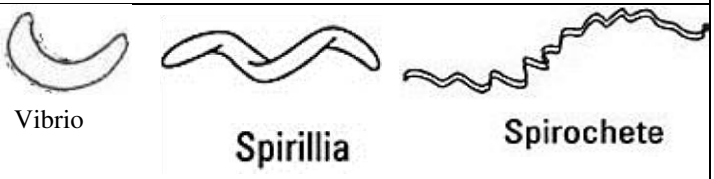
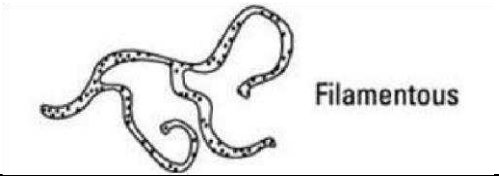
Generalised structure of a bacteria



CLASSIFICATION OF BACTERIA

Classification by shape

There are four main shapes of bacteria and they are as follows;

Type of shape	Structure
Rod shaped bacteria (bacillus/bacilli) They may occur as single rods or chains e.g. *Escherichia coli* which lives in the guts of humans and *Bacillus anthrax, bacillus cereus*	 *Bacillus* *Diplobacillus* *Streptobacillus*
Spherical shaped (cocci/coccus) They may occur in pairs (diplococcic), chains (streptococci), or clusters e.g *Staphylococcus*.	
Spiral shaped/curved bacteria Spiral shaped bacteria include *Spirillum* species. Curved shaped bacteria include the coma shaped (vibrios) bacteria such as *Vibrio cholera*	
Filamentous bacteria e.g *Actinomyces*	

Classification by type of respiration

a) **Aerobic bacteria.** These bacteria require oxygen for respiration. Obligate aerobes cannot survive without oxygen but facultative aerobic bacteria can survive in the absence of oxygen. **b) Anaerobic bacteria**

They respire without oxygen and obligate anaerobes are killed in the presence of oxygen. Facultative anaerobic bacteria can use oxygen but can respire without it.

Classification by type of nutrition

a) Autotrophic bacteria. These are bacteria which synthesize their own food using carbon dioxide and energy. They are divided into **photosynthetic and chemosynthetic bacteria** depending on the source of energy.

Photosynthetic bacteria use synthesize their own food using sun light energy to convert carbon dioxide into carbohydrates. Examples include; the blue-green bacteria, sulphur bacteria and cyano bacteria. **Chemosynthetic bacteria** synthesize their own food using energy from inorganic substances. The oxidation of H_2, NH_3, NO_2^-, H_2S, or Fe^{2+} supplies energy for these microorganisms**.** **b) Heterotrophic bacteria.** These feed on already made organic food.

Chemo-heterotrophic bacteria obtain energy from chemicals in food. They live as parasites or saprophytes.

Classification by staining reaction

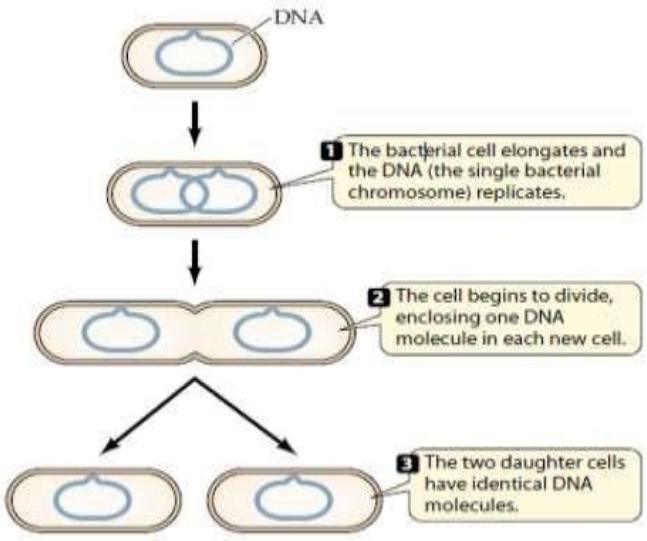
Gram positive bacteria; they stain purple with a gram stain. The cell wall lacks an extra outer membrane.

Gram negative bacteria; they stain pink with a gram stain. Their cell wall has an extra outer membrane which is made out of lipids and polysaccharides. The outer membrane gives them protection against penicillin and lysozymes.

REPRODUCTION IN BACTERIA

Bacteria reproduce asexually by binary fission and sexually by conjugation.

In binary fission, the bacterium cell lengthens and the DNA replicates. The cell then begins to divide enclosing one DNA molecule in each new cell. Two identical daughter cells are formed from the parent cell.



Respiration in bacteria

Bacteria may respire either aerobically or anaerobically. The following are the categories of bacteria known.

Obligate aerobes. These are bacteria that require oxygen for their survival. i.e they cannot live in environments that lack oxygen. E.g ***Mycobacterium tuberculosis*** **that causes TB.**

Obligate anaerobes. These are bacteria which live permanently in oxygen deficient conditions and respire only anaerobically i.e they do not require oxygen for their survival and can only survive in absence of oxygen. For example ***Clostridium tetani*** that cause tetanus

Facultative anaerobes. These respire aerobically but if oxygen is absent or in short supply, they can resort to anaerobic respiration. For example *Escherichia coli* (*E.coli*)

Nutrition in bacteria

Some bacteria are autotrophs i.e they manufacture their own food and are grouped into two;

i) **Photosynthetic bacteria.** These manufacture their own food using sun light energy. ii) **Chemosynthetic bacteria.** These manufacture their own food using energy obtained from oxidation of chemicals such as hydrogen sulphide. Chemoautotrophs use carbon dioxide as a source of carbon but obtain energy from chemical reactions through oxidation of inorganic materials. The oxidation of H_2, NH_3, NO_2^-, H_2S, or Fe^{2+} supplies energy for these microorganisms. Examples include nitrosomonas, nitrobacter, involved in the nitrogen cycle.

Other bacteria feed heterotrophically through **parasitism, saprohytism, commensalism or mutualism.**

ECONOMIC IMPORTANCE OF BACTERIA

1. They bring about decomposition of organic matter leading to recycling of nutrients in the ecosystem.
2. Saprophytic bacteria which obtain food from organic remains such as animal excreta, fallen leaves, meat decompose these substances Thus help in cleaning up the environment E.g. *Pseudomonas*
3. *Rhizobium* bacteria, living in root nodules of leguminous plant symbiotically, helps in fixing atmospheric nitrogen. Similarly, *Nitrosomanas* and *Nitrococcus* convert ammonium salt to nitrites. Nitrites are further changed to nitrates by *Nitrobacter* and *Nitrocystis.* It enables plants to uptake nitrogen.
4. Bacteria, while converting animal dung and other organic wastes to manure, help in production of fuel in form of bio gas
5. Manufacture of dairy products. Bacteria such as *Streptococcus lactis* convert milk sugar lactose into lactic acid that coagulates casein (milk protein). Then, milk is converted into curd, yoghurt, cheese etc needed for the industry.
6. Curing: The leaves of tea and tobacco, beans of coffee and coca are cured off their bitterness with the help of action of certain bacteria such as *Bacillus megatherium.*
7. They are used for making antibiotics, amino acids and enzymes
8. In humans, vitamin K and B complex are produced by the symbiotic bacteria (*E.coli*) while in animals it is used to break down cellulose.
9. Food Spoiling: Saprophytic bacteria always not only help in decomposition of dead matters, but they also cause the rotting of vegetables, fruits, meat, bread etc.
10. Bacteria like *Staphylococcus aureus* cause food poisoning and cause people diarrhea and vomiting.

11. Denitrification: Bacteria such as *Thiobacillus* and *Microbacillus* convert nitrate of the soil to the gaseous nitrogen.

Adaptations of bacteria for survival

1. They can respire both aerobically and anaerobically hence can survive a wide range of environments
2. They can reproduce both sexually and asexually which increases their chances of survival
3. They also have high reproductive rates and maintain high numbers which increases their chances of survival
4. They can feed both autotrophically and heterotrophically hence can have availability of nutrients all the time
5. They can form cysts which enable them to survive adverse condition such as drought
6. They are small in size hence can survive in a wide variety of habitats

KINGDOM PROTOCTISTA /PROTISTA

This consists of many single celled organisms and few multicellular organisms. All protists are eukaryotic.

Characteristics

- Most organisms are unicellular, but some few are multicellular
- They are eukaryotic (have membrane bound organelles e.g nucleus, mitochondria and chloroplasts ➢ Most are heterotrophic while a few are autotrophs/photosynthetic e.g euglena.
- They have special structures for locomotion e.g pseudopodia, cilia and flagella
- Some can make their own food e.g euglena while others depend on already made food e.g amoeba ➢ They are mainly aquatic organisms

Kingdom Protista has the following phyla

- Phylum rhizopoda
- Phylum ciliophoran
- Phylum mastigophora
- Phylum zoomastigina
- Phylum euglenophyta
- Phylum apicomplexa
- Phylum chlorophyta ➢ Phylum phaephyta
- Phylum rhodophyta
- Phylum oomycota

PHYLUM RHIZOPODA

Characteristics

- They move by means of pseudopodia (false feet)
- They reproduce asexually by binary fission
- They feed heterotrophically by phagocytosis

An example is **an amoeba**

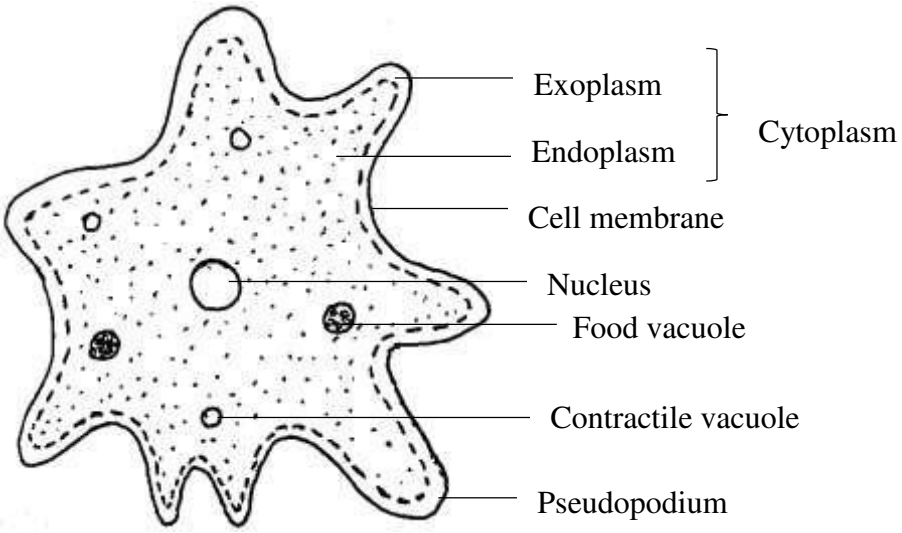
Amoeba

It is a unicellular organism. Most species are free living in fresh water and marine environments and in the soil water while others are parasitic e.g those living in the human gut and causing amoebic dysentery. Amoeba has no definite shape and its shape changes regularly. An amoeba has two layers, namely;

- Ectoplasm which is the outer layer
- Endoplasm which is the inner layer

The two layers are enclosed by a thin plasma membrane. It is fluid filled and it is packed with organelles like the nucleus.

Diagram of Amoeba



NUTRITION IN AMOEBA

Amoeba are heterotrophic, feeding on microscopic organisms like viruses, diatoms, algae, or food particles that may be found in water. The amoeba engulfs the food particle in a process called phagocytosis. Phagocytosis simply means engulfing and intake of solid food particles by an organism.

It simply refers to cell eating.

The process of feeding in amoeba is as follows.

When a n amoeba comes across a food particle, the pseudopodia forms and moves towards the food particle. The food particle is then engulfed with a drop of water to form a food vacuole in the cytoplasm. The lysosomes then secrete enzymes into the food vacuole and the food is then digested by the enzymes. The soluble products of digestion then diffuse into the surrounding cytoplasm (are absorbed). The vesicle then moves towards the cell surface and fuses with the plasma membrane and the undigested materials are discharged to the outside of the amoeba cell.

NB. An amoeba carries out **intracellular digestion**. This is a type of digestion whereby the food substance is digested within the cell.

See fig. 4.9 Functional approach, page 56. Draw. Also read about reproduction and locomotion in amoeba

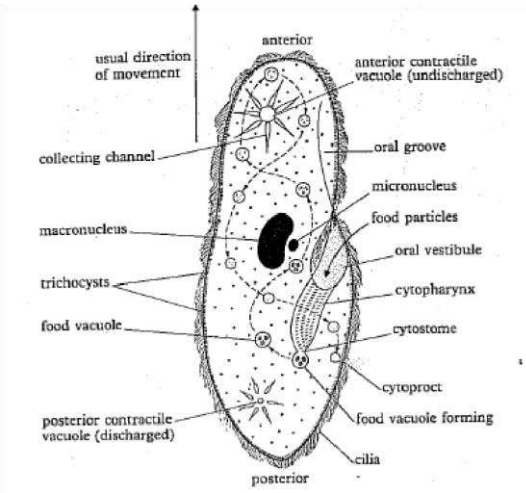
PHYLUM CILIOPHORA (CILIATES)

Characteristics

- They are unicellular
- Have cilia for locomotion. Cilia are rows of cytoplasmic filaments extending from the surface. The cilia contract rhythmically causing the waves to propel the organism forward and backwards. They also collect food for the organism
- Their cilia have a 9+2 tubule arrangement
- They feed heterotrophically by phagocytosis
- Reproduce asexually by binary fission and sexually by conjugation
- Their habitat is fresh water and marine water
- Have two contractile vacuoles for excretion and osmoregulation
- They have two nuclei, the larger macro nucleus (mega nucleus) and the micronucleus. which the macronucleus controls all cell metabolic activities while the micro nucleus controls sexual reproduction

Examples include **Paramecium, Stentor, Vorticella, and Didinia**

Diagram of paramecium (FA page 43)



PHYLUM ZOOMASTIGINA (Flagellates)

Examples include trypanosoma which are blood parasites which cause African trypanosomiasis (sleeping sickness in humans and nagana in animals)

Characteristics

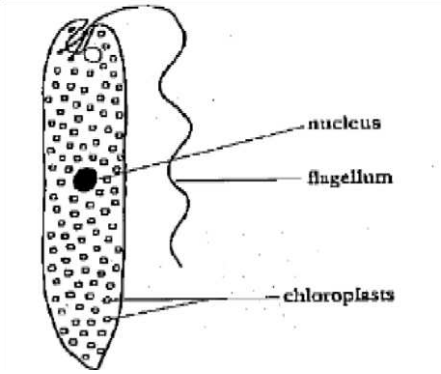
- They have atleast one flagellum for locomotion
- They are heterotrophic, living as parasites
- They are unicellular
- The reproduce both asexually and sexually

- They bear a 9+2 tubule arrangement

PHYLUM EUGLENOPHYTA (euglenoid flagellates) The only member is euglena. Euglena has many species.

Characteristics

- They are mostly unicellular
- They reproduce asexually
- They move by flagella
- Some species have chlorophyll for photosynthesis while others are lack chlorophyll and are heterotrophic
- They are aquatic, living in both fresh and marine waters.



PHYLUM APICOMPLEXA (SPOROZOANS)

Members include plasmodium which causes malaria in humans

Characteristics

- They are unicellular
- They are heterotrophic (mainly parasitic)
- They lack locomotory structures
- They are spore producing parasites of animals
- They reproduce sexually and asexually by multiple fission
- Their lifecycles are complex involving several animal hosts

Life cycle of plasmodium

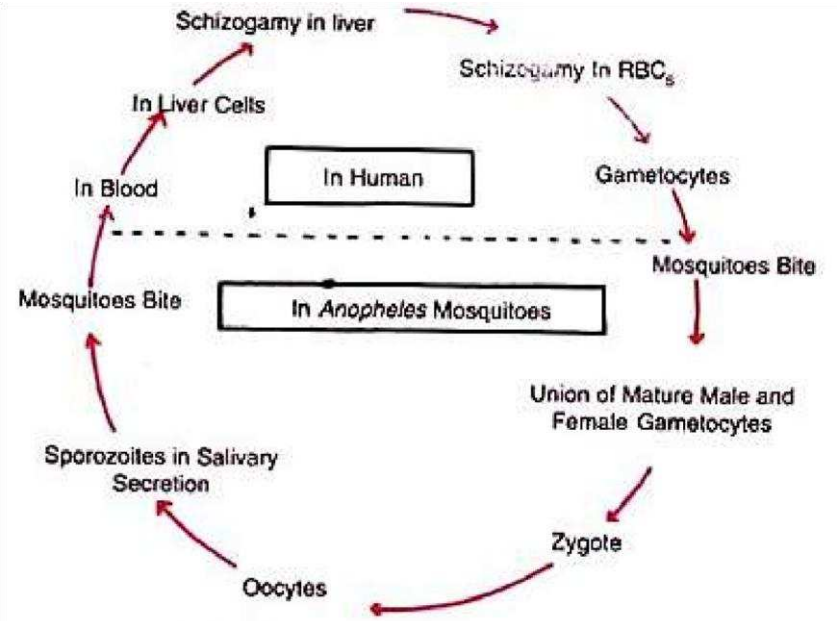
The malaria parasite exhibits a complex life cycle involving an insect vector (mosquito) and a vertebrate host (human). Four Plasmodium species infect humans: P. falciparum, P. vivax, P. ovale and P. malariae. All four species exhibit a similar life cycle with only minor variations.

An infected female anopheles mosquito bites a healthy human, injecting plasmodium parasites in form of sporozoites (infective stage) with saliva into blood stream. The mosquito saliva contains antihemostatic and anti-inflammatory enzymes that disrupt blood clotting and inhibit the pain reaction. The sporozoites move to the liver through blood stream and invade the liver cells (hepatocytes). In liver cells the sporozoites multiply asexually for about 7-10 days to form merozoites, a process called exoerythrocytic schizogony. No symptoms are caused. The merozoites are then released into blood stream and invade the red blood cells. The merozoites divide and multiply asexually inside the red

blood cells (erythrocytic schizogony) and large numbers of merozoites cause the red blood cells to burst and they infect more red blood cells.

Some merozoites Instead of replicating, develop into sexual forms of the parasite, called **gametocytes** that circulate in the blood stream.

When a mosquito bites an infected human, it ingests the gametocytes along with blood, which develop further into mature sex cells called gametes in the mosquito mid gut. Fertilisation occurs in the mosquito's digestive tract, and a zygote (ookinete) forms. An oocyst develops from the zygote in the wall of the mosquito mid gut. Inside the oocyst, thousands of active sporozoites develop. The oocyst eventually bursts, releasing sporozoites into the body cavity that travel to the mosquito's salivary glands. The cycle of human infection begins again when the mosquito bites another person



The female anopheles mosquito is the **primary host** while man is the **secondary host**.

PHYLUM CHLOROPHYTA (green algae)

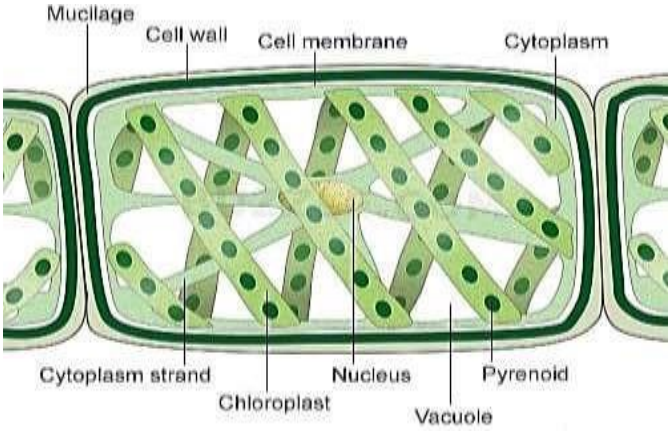
Characteristics

- Some are unicellular while others are multicellular
- They contain chlorophyll and therefore they are photosynthetic
- Their cell walls contain cellulose
- They reproduce sexually by conjugation and asexually by fragmentation ➢ They are aquatic

Examples include; Spirogyra, chlorella, chlamydomonas and volvox.

- Spirogyra is a filamentous alga that lives in fresh water ponds
- Chlorella is a non-filamentous, non-motile single celled alga that lives in fresh water ponds, and swimming pools.
- Chlamydominas is a motile unicellular alga

Diagram of spirogyra



PHYLUM PHAEOPHYTA (brown algae)

Characteristics

- They contain brown pigments (fucoxanthin) as the dominant pigment
- They contain chlorophyll and hence autotrophic/photosynthetic
- Some are multicellular, others are unicellular
- They are aquatic, living in marine waters (commonly known as sea weeds) Examples include; Fucus, laminaria and ascophyllum.

PHYLUM RHODOPHYTA (red algae)

Characteristics

- Contain a red pigment called phycoerythrin which is the dominant pigment
- Contain a blue pigment called phycocyanin
- They also contain chlorophyll and are photosynthetic
- Contain both unicellular and multicellular forms
- They are aquatic, living in marine waters

Examples include; **chodrus and rhodomela**

PHYLUM OOMYCOTA

They have cellulose cell wall

They have flagellated spores

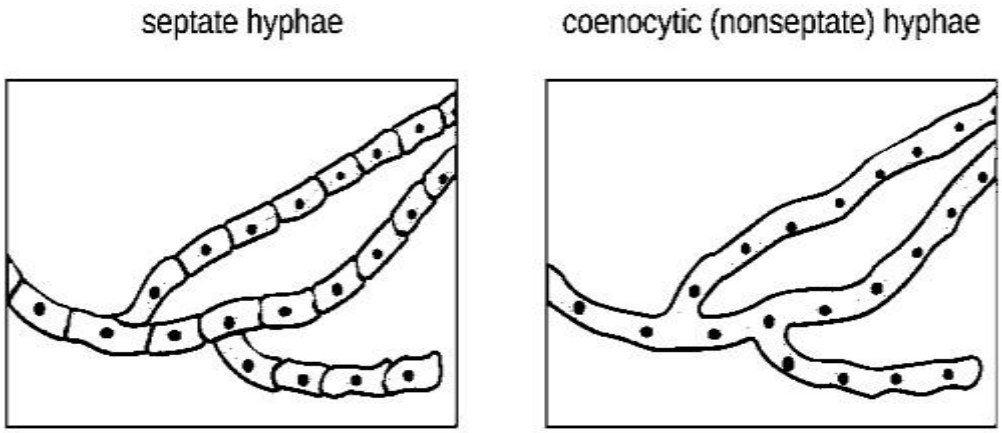
NB. Oomycotes are similar to fungi, but not under fungi because they have a cellulose cell wall

KINGDOM FUNGI

These are eukaryotic organisms ranging from unicellular like yeast to multicellular e.g fungi, toad stols, puffballs, etc. Examples include; mushrooms, Rhizopus (bread mould), yeast, smurts, puff balls, toad stools, mucor, penicillium.

The body of fungi is a mycelium which is a network of hyphae. The hyphae are threadlike, tubular and branched filaments and are the basic units of a fungus. Some hyphae are divided into compartments by cross walls called septa (singular septum. These are called septate hyphae while others have no cross walls/septae and these are non-septate hyphae/coenocytic hypha.

Some fungi do not form hyphae, occur as **single-celled fungi e.g yeast, candida albicans**



General characteristics of fungi

- They lack chlorophyll hence they are heterotrophic
- They feed saprophytically and some few are parasitic
- They carry out extracellular digestion
- They have eukaryotic cells with a cell wall made of chitin. They have no cellulose
- They reproduce both asexually and sexually. Asexual reproduction is by means of spores while sexual reproduction is by conjugation.
- Their body is mycelium which consists of tiny threadlike tubular and branched structures called hyphae. The hyphae may be septate or aseptate
- They store carbohydrates in form of glycogen but not starch
- A few a unicellular but majority are multicellular
- They produce many spores with no flagella

Kingdom Fungi is classified into three main phyla and these are

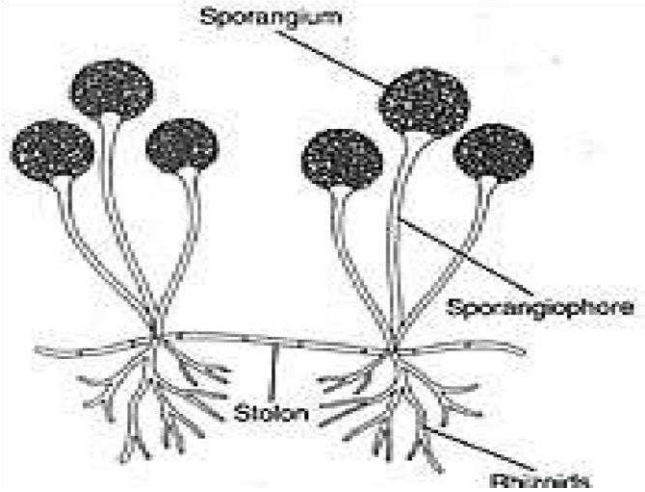
- Phylum Zygomycota
- Phylum Ascomycota
- Phylum Basidiomycota

PHYLUM ZYGOMYCOTA

- They have a vertical hyphae called sporangiophore/stalk with sporangia at the top
- They have branched hyphae/horizontal hyphae called mycelium
- Network of numerous rhizoids for absorption of nutrients
- They have non septate hyphae
- They reproduce both sexually and asexually
- Asexual reproduction is by asexual spores called sporangiospores produced in the sporangium or by conidia. The sporangia are born on stalks called sporangiophores
- Sexual reproduction is by conjugation to form zygospores. Zygosores are the sexual spores.

The most common examples include **mucor** and **bread mould** (*Rhizopus stolonifer*).

Structure of bread mould (Rhizopus)



Rhizoid

Zygomycota is divided into two classes; **trichomycetes** and **zygomycetes.**

PHYLUM ASCOMYCOTA

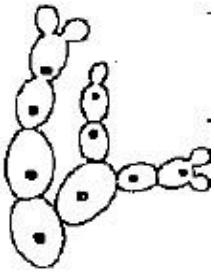
Ascomycota has the highest number of fungal species.

Characteristics

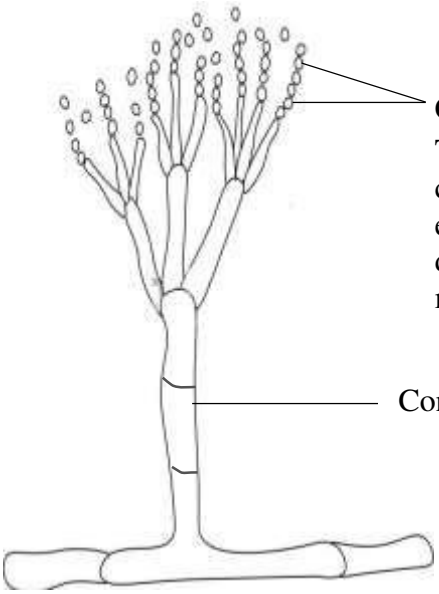
- They have septate hyphae i.e hyphae have cross walls called septa
- They reproduce both sexually and asexually. Asexual reproduction is by means of asexual spores called conidia at the tip of special hyphae called conidiophores. Yeast reproduces asexually by budding or fission
- Sexual reproduction is by conjugation to form sexual spores called ascospores. The sexual spores (ascospores) are produced within microscopic sacs called asci (singular ascus)
- The ascus is commonly cylindrical in shape
- The ascus may be single walled or double walled, may open to release spores or may remain closed and not release the spores.

Examples include **baker's yeast saccharomyces, aspergillus, and penicillium**. Yeast is a unicellular fungus with oval shaped cells.

Budding yeast

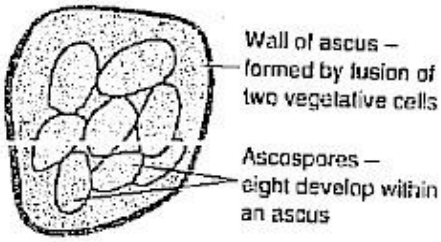


Penicillium



The conidia are produced in chains. They are not enclosed and are easily dispersed as soon as they mature

Ascus containing



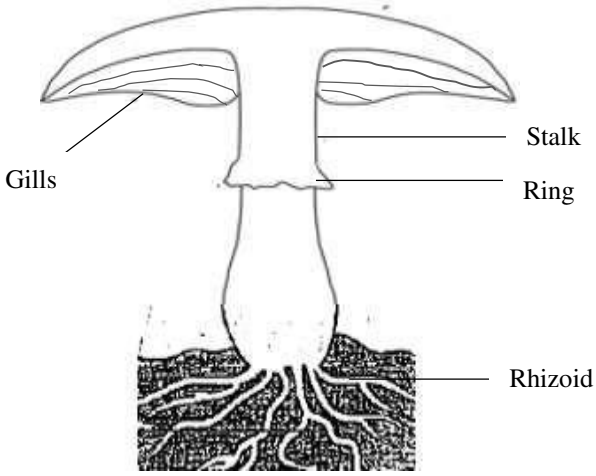
PHYLUM BASIDIOMYCOTA

Characteristics

- Reproduce sexually by producing sexual spores called basidiospores from a small club-shaped structure called basidia
- They also reproduce asexually by sporulation, but rarely
- They have septate hyphae
- Produce fruiting bodies

Examples include **mushrooms, toad stools, puff balls, cup fungi**

Drawing of mushroom



NUTRITION IN FUNGI

Fungi are **heterotrophs**; being either **saprophytic or parasitic or mutualistic**. The parasitic fungi live in or on the tissues of other organisms called hosts and absorb nutrients from the bodies of their hosts. The saprophytic fungi feed on dead and decaying organic matter. They secrete enzymes at the growing tips of hyphae. The enzymes enable the hyphae to penetrate the bodies of the substrates on which they are feeding. The enzymes breakdown the organic matter/food substance externally into simple soluble substances which are then absorbed into the protoplasm of the fungus. This type of digestion where food substances are digested outside the cell is known as **extracellular digestion.**

The mutualistic fungi live in association with other organisms of different species in which both the organisms mutually benefit from each other. For example, **lichens** (an association between fungus and alga), **mycorrhiza** (an association between a fungus and a plant root)

ECONOMIC IMPORTANCE OF FUNGI

1. Fungi are a source of food to man for example mushrooms are eaten by man
2. They cause decomposition of organic matter hence recycling nutrients
3. Fungi for example yeast is used in the manufacture of alcohol by alcoholic fermentation
4. Yeast is also used in baking to make bread
5. Some fungi are used in the production of drugs/antibiotics for example penicillin from penicillium
6. Fungi cause ripening of fruits
7. Some fungi cause diseases to humans like ring worms, candiadiasi caused by *candida albicans.* They also cause plant diseases such as potato bright.
8. They produce toxins (aflatoxins) which can cause cancer
9. Some fungi are poisonous to man
10. They cause destruction of important materials such as shoes, bags
11. Some fungi are used in biotechnology for example the yeast *Saccharomyces cerevisae* is used in gene cloning experiments
12. Some fungi are used in production of dyes
13. Some species of fungi are used to trap mosquito larva thus controlling malaria
14. Some fungi are ecological indicators for levels of pollution in a given environment, for example lichen population increases with decrease in Sulphur dioxide levels.

KINGDOM PLANTAE

This includes all the plants

Characteristics

- They have chlorophyll and are photosynthetic. Very few lack chlorophyll and are parasitic
- They have a cell wall made of cellulose
- They are multicellular eukaryotes
- They reproduce both sexually and asexually
- They show alternation of generations in their lifecycles
- They do not locomote (they do not move from one place to another)
- They respond to stimuli slowly
- Body shape and number of body organs not fixed
- They live both on land and in water

Kingdom plantae is divided into four major phyla which are;

- Phylum Bryophyta
- Phylum Pteridophyta
- Phylum coniferophyta
- Phylum Angiospermatophyta

PHYLUM BRYOPHYTA

These are the bryophytes. They are the mosses and liverworts. They live in damp/moist places such as damp verandahs, damp tree trunks, rocks, river banks, damp roofs, damp water tank surfaces, damp logs of trees etc. Examples include; mosses, liverworts and hornworts

Characteristics

(i) They have a simple body called thallus differentiated into simple leaves/spirally arranged leaf like structures and stem
(ii) They have no true roots but are anchored in the ground by filamentous rhizoids
(iii) They lack xylem and phloem i.e no conducting tissues
(iv) They have a seta/stalk/sporangiophore with the sporangium/ spore capsule at the tip
(v) They show alternation of generation i.e exhibit both sexual and asexual stages during reproduction
(vi) The sporophyte is attached to and dependent on the gametophyte anchored by rhizoids
(vii) The gametophyte is the dominant generation
(viii) Spores are produced by the sporophyte
(ix) They lack cuticle
(x) They are eukaryotic and have cellulose cell walls
(xi) Nutrition is autotrophic

Due to absence of cuticle, bryophytes can take in water and mineral salts over the whole body surface hence no need of a vascular system. But they face a problem of dessication and cannot survive in dry areas.

Phylum bryophyta is divided into two classes;

Class hepaticae (liverworts)
Class Musci (mosses)

Class hepaticae

These are the **liverworts**

- The gametophyte is a flattened structure called thallus
- Have unicellular rhizoids which provide anchorage
- The sporophyte capsule splits into four halves to allow easy dispersal of spores **Drawing of liverwort**

Class musci

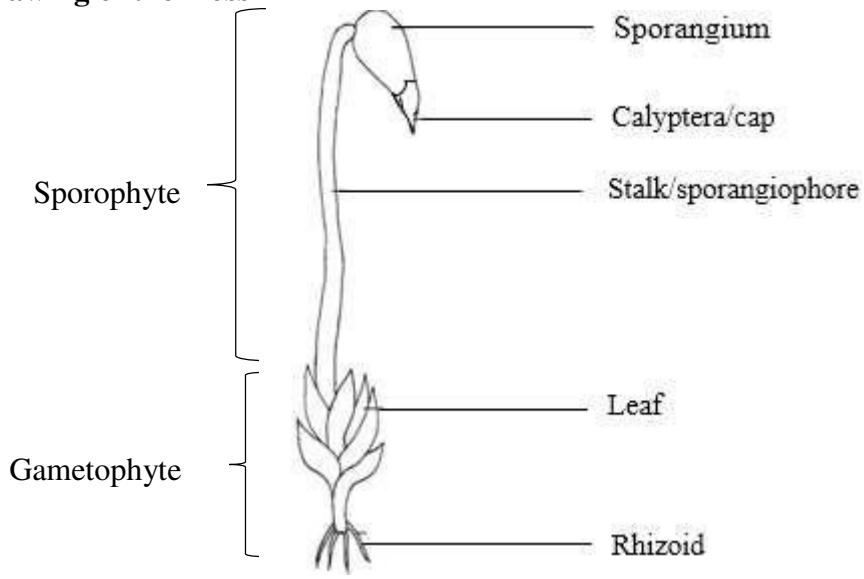
These are the **mosses**

Gametophyte is leafy and has a stem

Have spirally arranged leaves/leaf like structures

Rhizoids are multicellular

Drawing of the moss



ALTERNATION OF GENERATIONS

This is where there are two distinct stages/generations in the life cycle of an organism alternating with each other; a haploid stage called gametophyte which produces gametes and a diploid stage called sporophyte which produces spores.

The haploid gametophyte produces asexually by mitosis to give haploid gametes which fuse to give a diploid zygote that grows into a diploid sporophyte

The diploid sporophyte produces sexually by meiosis to give haploid spores which germinate and grow into a haploid gametophyte which completes the cycle.

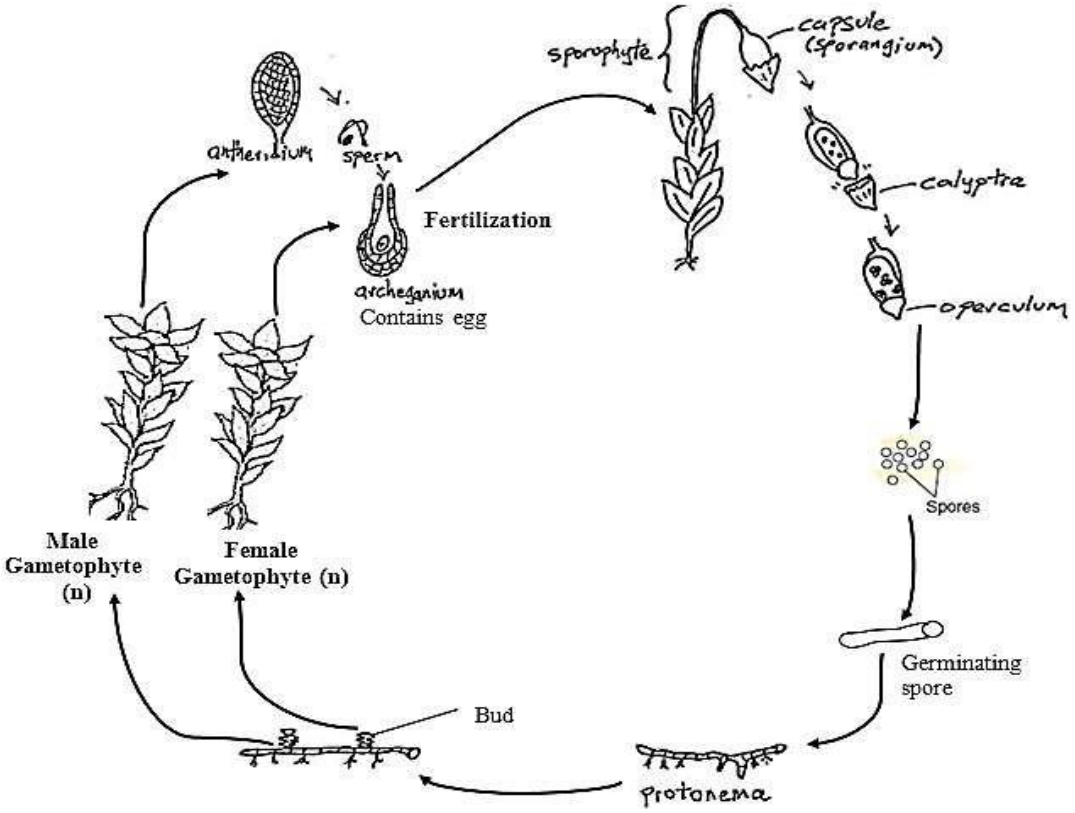
The life cycle of a typical moss

The lifecycle of a moss shows alternation of generations involving an **asexual** spore producing stage called **sporophyte generation** and a **sexual** gamete producing stage called **gametophyte generation**

The life cycle starts with a mature gametophyte which is haploid. This produces gametes by mitosis from special gamete forming organs/sex organs developed at the tip of leafy stems. When mature, the male sex organs called **antheridia produces sperms (antherozoids)** while the female sex organ called **archegonia produces eggs.** The sperms are biflagellated and when water is available, they swim to the archegonia and fuse with the eggs to form a diploid zygote. After fertilization, the zygote develops and grows into a **diploid sporophyte** which remains attached to and dependent on the gametophyte. The sporophyte consists of a stalk with a spore capsule (sporangium) at the tip.

In the spore capsule, the spores are formed by meiosis from the spore mother cells and are therefore haploid. When mature, the spore capsule splits to release the haploid spores. The spores are then dispersed by wind to different areas. When they land on moist ground, the spores germinate into a green filamentous structure called **protonema** which grows into the gametophyte and the cycle is complete.

Diagram summarizing the life cycle of a moss e.g Funaria



. **NOTE**

- ✓ The gametophyte is the dominant generation
- ✓ Fertilization takes place in the archegonia of the gametophyte
- ✓ The antheridia and archegonia may be located on the same plant or different plants.
- ✓ The leafy gametophyte is photosynthetic, while the smaller sporophyte is not, and is nutritionally dependent on the gametophyte.
- ✓ Water is required to carry sperm to the egg.
- ✓ The archegonium produces a single egg while the antheridium produces numerous sperms

PHYLUM PTERIDOPHYTA/FILICINOPHYTA

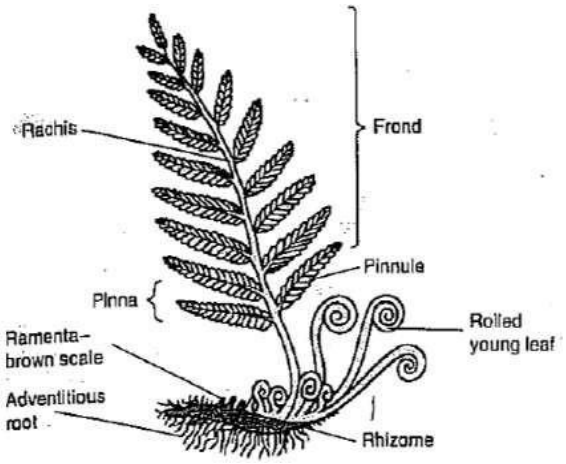
These are the ferns. They are common in tropical rain forests where temperature, light and moisture are favourable.

Characteristics

- They have true stems, roots and leaves
- They have vascular tissues i.e xylem and phloem
- They have an underground stem (rhizome) with vertically growing leaves
- They have adventitious roots. These anchor the plant and absorb water and dissolved mineral salts from the soil
- They have large leaves called fronds
- They have sori on the underside of the leaves. Sori (singular sorus) are clusters/groups of sporangia. The sori are protected by the indusium
- Spores are produced in the sporangia
- They show alternation of generation i.e exhibit both sexual and asexual stages during reproduction
  - The sporophyte is the dominant generation
- The gametophyte is a simple heart shaped structure called prothalus. It is green and photosynthetic and is anchored by rhizoids

Common examples include; pteridium and dryopteris

Structure of a fern



Life cycle of a fern

The lifecycle of a fern shows alternation of generations involving an **asexual** spore producing stage called **sporophyte generation** and a **sexual** gamete producing stage called **gametophyte generation**. The sporophyte is diploid and is the dominant generation. The gametophyte is haploid.

The lifecycle starts with a mature diploid sporophyte. It has sporangia on the underside of leaves. The sporangia are in groups called sori. Each sporangium contains spore mother cells which divide by **meiosis** to produce haploid spores. When mature, the sporangia split open and releses the spores which are dispersed by wind to different places. When moisture is present, the spores germinate into a heartshaped prothallus which is the haploid gametophyte. The prothalus is green and photosynthetic and is anchored into the ground by unicellular rhizoids. The prothalus lacks cuticle and can only survive in damp conditions

The gametophyte reproduces sexually. It develops sex organs on its underside which produce haploid gametes by mitosis. The male sex organs called **antheridia produces sperms (antherozoids)** while the female sex organ called **archegonia produces eggs.** The sperms are multiflagellated/ciliated and swim in water to the archegonia and fertilize the eggs producing a diploid zygote. The zygote grows

into a young sporophyte which is diploid. This at first depends on the gametophytes but later develops roots and leaves and becomes self-supporting, thus completing the cycle

See diagrammatic representation of life cycle of fern on page 408, Functional Approach, and page 87, Understanding Biology

COMPARISON OF BRYOPHYTES AND PTERIDOPHYTES

SIMILARITIES

- Both show alternation of generations involving two distinct stages
- Both reproduce asexually by spores and sexually by gametes
- In both, the gametes are produced by gametophytes and spores are produce by the sporophyte
- In both, spores are produced by meiosis and are haploid while gametes are produced by mitosis
- Both have antheridia and archegonia
- In both, the sporophyte grows out of the gametophyte
- Both lack flowers and seeds
- In both, the male gamete is motile
- Both grow in damp soils/ organic matter
- In both the gametophyte is anchored by the rhizoids

DIFFERENCES

BRYOPHYTES	PTERIDOPHYTES
Gametophyte dominant	Sporophyte dominant
No vascular tissue	Have vascular tissue
No true roots, stems and leaves (thallus body)	Differentiated into roots, stems and leaves
No cuticle	Have cuticle
No underground stem	Have rhizome
Lack sori	Have sori on underside of the leaves
Have rhizoids	Lack rhizoids
Sperms are biflagellated	Sperms are multifagellated
Sporophyte depends on the gametophyte	Sporophyte is self-supporting

NB. For successful reproduction, mosses and ferns require water because the sperms from antheridia have to swim in the water to reach the egg in the archegonia for fertilization to occur. If there is no water, the sperms dry and die before reaching and fertilizing the egg.

SIGNIFICANCE OF ALTERNATION OF GENERATION

(i) It enables the plants to colonise different habitats in the ecosystem

(ii) It enables plants to survive adverse environmental conditions e.g spores can survive can survive harsh environmental conditions and germinate when favourable conditions are available

(iii) The sporophyte generation produces large numbers of spores hence rapid multiplication to maintain high numbers

(iv) Gametes are formed by meiosis which brings about genetic variations

Question
How are ferns more adapted to life on land than mosses?

Seed bearing plants.
These bear seeds and are the most successful plants on land. They include gymnosperms (coniferous plants) which bears no flowers and angiosperms which bear flower. They are divided into two phyla, coniferophyta and Angiospermatophyta

PHYLUM CONIFEROPHYTA
These are the conifers
Characteristics

- They have no flowers and fruits
- They bear cones. Female cones produce ovules while male cones produce pollen
- Their seeds are naked i.e the seeds are not enclosed in a fruit
- They have needle-like leaves protected by a waxy cuticle
- They have a well-developed vascular system ➢ They have no flowers and fruits Examples include; **pine, cedars, spruce**

PHYLUM ANGIOSPERMATOPHYTA
These are the flowering plants, commonly known as angiosperms. They form the largest phylum of plants occupying a wide variety of habitats

Characteristics

- Their body is differentiated into true roots, stems and leaves
- They produce flowers
- The seeds are enclosed in a fruit. The seeds develop from ovules while the fruit develops from the ovary after fertilization
- They have a well-developed vascular system
- They undergo double fertilization forming a zygote and endosperm

Phylum Angiospermatophyta is divided into two classes

- Class monocotyledoneae
- Class dicotyledoneae

Class monocotyledoneae
These are the monocotyledonous plants.

They have the following characteristics.

- The embryo has seeds one cotyledon/seed leaf
- Parallel veined leaves
- Leaf sheath
- Fibrous roots
- Vascular bundles distributed randomly in the stem

- They lack a vascular cambium in their stem, therefore, they don't undergo secondary thickening
- Narrow and elongated leaves
- Their flowers are in threes or multiples of three
- They undergo hypogeal germination

Class Dicotyledoneae

These are the dicotyledonous plants.

They have the following characteristics

- The embryo has two cotyledons
- Leaves with a network of veins
- Leaves with a broad lamina
- One main root with numerous lateral branches
- Leaves attached to the stem by a solid stalk
- Vascular bundles radially arranged on the ring of the cambium
- A central pith
- A clear cortex
- They have a vascular cambium and therefor undergo secondary growth
- The flowers are arranged in fours or fives or in multiples of four or five
- They undergo epigeal germination

Adaptations of seed bearing plants to life on land

(i) They possess well developed roots for absorption of water and dissolved mineral salts from the soil

(ii) Leaves possess stomata for gaseous exchange

(iii) Leaves and stems are covered by a waxy cuticle which minimises water loss

(iv) They undergo secondary growth which enable seed bearing plants to compete effectively for light and other resources

(v) The fertilised ovule (seed) is retained for some time on the parent plant (sporophyte) from which it obtains protection and food before dispersal.

(vi) Fertilisation is not dependent on water therefore reduces necessity for water inside the sporophyte which is well adapted for terrestrial life.

Questions

1. Compare conifers and angiosperms
2. What advantages do seed bearing plants have over bryophytes and pteridophytes?
3. What advantages do angiosperms have over conifers
4. Explain the problems faced by terrestrial plants
5. Explain the economic importance of plants in the ecosystem
6. State the adaptations of algae to their environment
7. State the importance of algae

KINGDOM ANIMALIA

General characteristics

- They are multicellular eukaryotes
- They are heterotrophic i.e they feed on already made food
- Their cells lack cell walls
- They locomote
- Their bodies are organized into cells, tissues, organs, and systems
- They have a definite body shape (have a fixed body shape and number of body organs)
- They have a well-developed nervous system except the sponges
- Their bodies are symmetrical i.e they can be divided into two or more equal parts which are mirror images of each other.

BODY SYMETRY OF ANIMALS

This is where the animal's body and body parts can be divided into two or more equal parts. The different types of symmetry in animals are; (i) **Bilateral symmetry**

This is a type of symmetry where the animal's body can be divided into two equal halves in only one plane i.e along only one line. Organisms with bilateral symmetry include birds, reptiles, fish, amphibians etc.

(ii) **Radial symmetrical body**

This is a type of symmetry where the animal's body can be divided into two equal halves in more than one plane i.e along many lines. Organisms with this symmetry include star fish, sea urchin, bristle stars, etc.

NB. **Asymmetrical body** is where an organism cannot be divided into two equal parts in any plane e.g tape worms and liver flukes.

COELOM

This is the main body cavity in animals between the body wall and the digestive tract. The coelom is a fluid filled cavity which contains and surrounds the digestive tract. It is found in animals that develop from an embryo with three tissue layers i.e **ectoderm, mesoderm and endoderm**. The body wall is the ectoderm. The coelom originates from the mesoderm.

Basing on the body cavity/coelom, animals are classified into two; namely **coelomates and acoelomates.** Coelomates possess the coelom while acoelomates lack a coelom. Some animals have a false coelom and are called **pseudocoelomates**.

Question.

State the importance of the coelom

Importance of the coelom

1. It provides space for enlargement of internal organs e.g kidneys, lungs, liver etc
2. The coelom allows independent functioning of the alimentary canal and the body wall
3. In some organisms like earth worms, the fluid filled coelom provides a supportive structure in form of hydrostatic skeleton
4. The coelomic fluid also bathes the internal organs and acts as a shock absorber
5. Coelomic fluid transport food, water, waste materials and respiratory gases in some animals e.g insects

DEVELOPMENT OF THE BODY OF ANIMALS

During embryo development in some animals, the cells are arranged into three distinct layers from which tissues and organs develop. These layers are ectoderm, mesoderm and endoderm. Basing on these germinal layers, animals are classified as **diploblastic or triploblastic**.

(i) Diploblastic animals are animals whose body is divided into two body layers. They develop from ectoderm and endoderm germinal layers at embryonic stage

(ii) Triploblastic animals are animals whose bodies have three layers. They develop from three germinal layers; ectoderm, mesoderm and endoderm.

BODY SEGMENTATION AND METAMERISM

Segmentation is the dividing of the body into segments. Some animals are segmented while others are non-segmented. A few are pseudo segmented.

In metameric segmentation, there is repetition of tissues and organs at intervals along the body thus dividing the body into linear series of similar parts/segments called metemers. The segmentation originates internally from the mesoderm. It results into repetition of mesoderm and ectoderm derived tissues and organs. It is especially seen in annelids.

In non-metameric segmentation, segmentation is only confined to ectodermally derived tissues. The mesoderm is not involved and segments only originate from the ectoderm. It is mainly seen in arthropods.

CLASSIFICATION OF ANIMALS

Animals are largely divided into two main groups i.e **vertebrates and invertebrates.**

Invertebrates are animals which do not have a back bone (vertebral column) they fall under different phyla as outlined below.

Vertebrates are animals with a back bone (vertebral column). A backbone consists of a column of cylindrical bones joined end to end and they protect the spinal cord. All Vertebrates belong to phylum chordate

The different phyla under kingdom Animalia are;

- Phylum porifera
- Phylum coelenterata
- Phylum Platyhelminthes
- Phylum nematode
- Phylum annelida
- Phylum Mollusca
- Phylum arthropoda
- Phylum Echinodermata
- Phylum chordata

PHYLUM PORIFERA

These are the **sponges.** They are the simplest forms of animals**. The word polifera means pore bearers. Characteristics**

- They have several pores on their bodies through which water containing food enters their bodies. These pores are called **ostia** (singular **ostium**). Water is drawn through the pores into a central

cavity, the **spongocoel**, and then flows out of the sponge through a larger opening called the **osculum.**

- They have no true tissues and lack distinct organs. They consist of cells that are functionally separted from each other i.e they belong to cellular level of organization
- They are sessile animals i.e they do not move but attach themselves to rock surfaces
- They are asymmetrical
- They are diploblastic
- Their skeleton is made of silica
- They reproduce asexually by budding
- They are aquatic

Check functional approach page 45 and look at the structure of a sponge. Look at the different cells and their functions

PHYLUM COELENTERATA/CNIDARIA

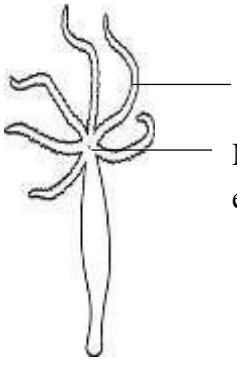
Organisms in this phylum are called **coelenterates or cnidarians**.

Characteristics

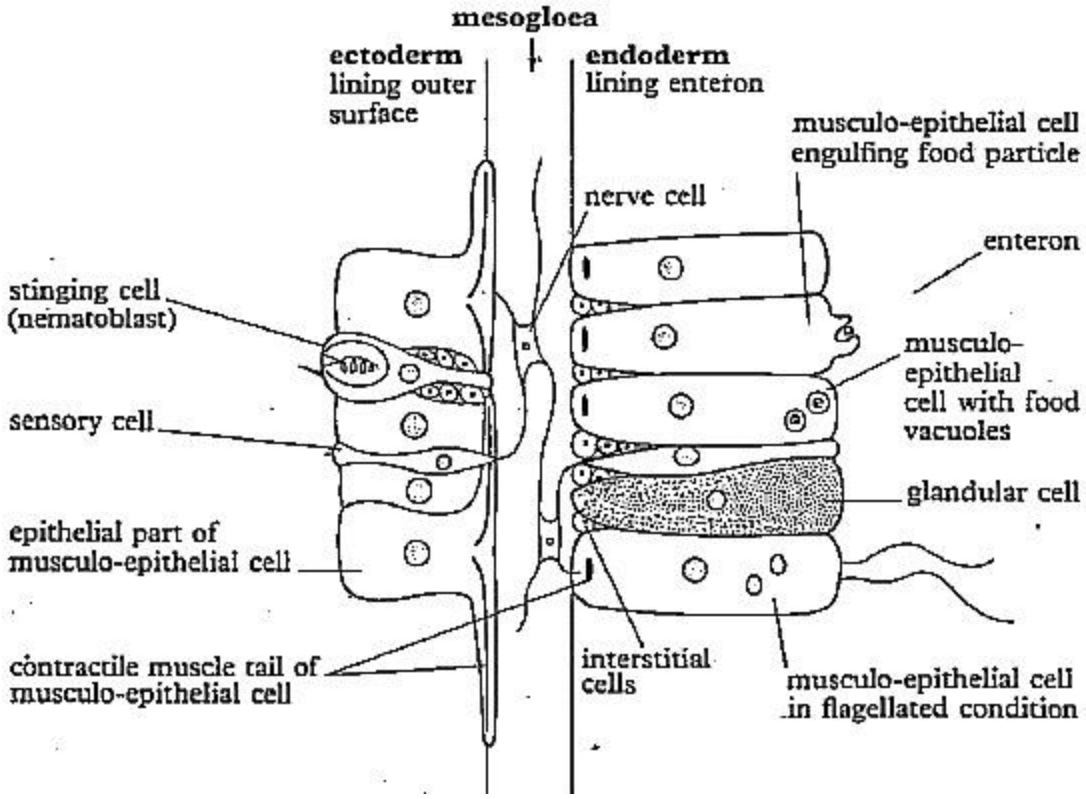
- They have radial symmetry
- They are diploblastic animals i.e. their bodies have two layers i.e ectoderm and endoderm. Between the two layers lies a jelly-like non-cellular layer called mesogloea.
- They have nematoblasts (stinging cells). The stinging cells release a chemical which paralyses the prey
- They have tentacles around their mouth. The tentacles are used for capturing food. Tentacles contain nematoblast cells
- They occur in two main forms (show polymorphism). The two forms are medusa and polyp forms. Some have both forms in their life cycle while others have one.Polyps are cylindrical forms that adhere to the substrate. A medusa (plural, *medusae*) resembles a flattened, mouth-down version of the polyp. ➢ They have a simple nervous system
- They have only one opening which acts as both the mouth and anus
- They belong to tissue level of organization

Examples include; hydra, jelly fish, sea anemones, corals, and Portuguese man of war Examples of the polyp form include hydras and sea anemones

External structure of hydra



Structure showing body wall of hydra



State the function of each of the cells indicated above

PHYLUM PLATYHELMINTHES (flat worms)

Members include tapeworm (taenia), blood fluke (Schistosoma), liver fluke (*Fasciola hepatica*) and planaria

Characteristics

- They have dorso-ventrally flattened bodied
- They are Triploblastic i.e. have three body layers between these two is the
- They have bilateral symmetry
- They have a mouth but no anus i.e they have only one opening
- They are hermaphrodites
- Their bodies are unsegmented
- They lack the alimentary canal
- They have flame cells for excretion and osmoregulation
- They are at organ level of organization
- They are acoelomate. They have only one body cavity (gut/enteron)
- They lack a blood vascular system

Examples include tape worms, liver flukes, blood flukes, and planaria

Platyhelminthes is divided into three classes

Class turbellaria

These are free living and have a ciliated outer surface.

They are aquatic

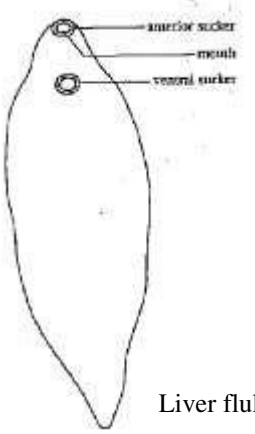
The beating of cilia propels the animals along and creates a turbulence in water hence the name of the class

An example is planaria

Class trematoda (the flukes)

- They are parasitic (endoparasites)
- They have suckers for attachment to the host
- They do not have a cuticle on their body surface
- They have complex life cycles with more than one host
- Their gut/enteron is highly branched

Examples are **liver fluke (*Fasciola hepatica*) and blood fluke (schistosoma) which causes schistosomiasis/bilharzia**



Liver fluke

Class cestoda (tape worms)

- They are endoparasites
- They have no gut cavity/enteron (they absorb their food from the host)
- Have hooks and suckers for attachment to the host
- They have an elongated body with no cilia
- They are unsegmented
- Body divided into sexually reproducing sections called proglottids
- They have a thick cuticle

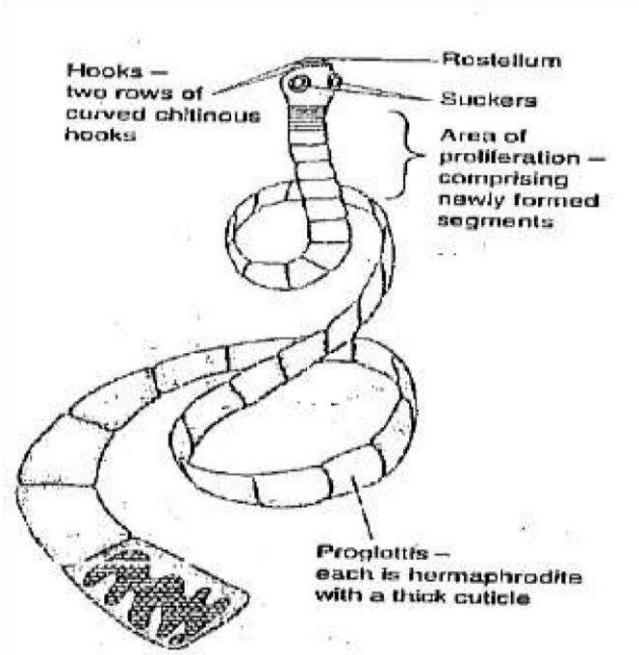
There are two common species of tape worms known. These are; *Taenia saginata* (beef tape worm) and *Taenia solium* (pork tape worm).

Adult tape worms live in the human intestines and are attached to the intestine walls by hooks and suckers. They absorb nutrients from the digested food.

Structure of a tape worm

It has a knob like head called scolex with hooks and suckers. The hooks and suckers attach the worm to the walls of the intestines.

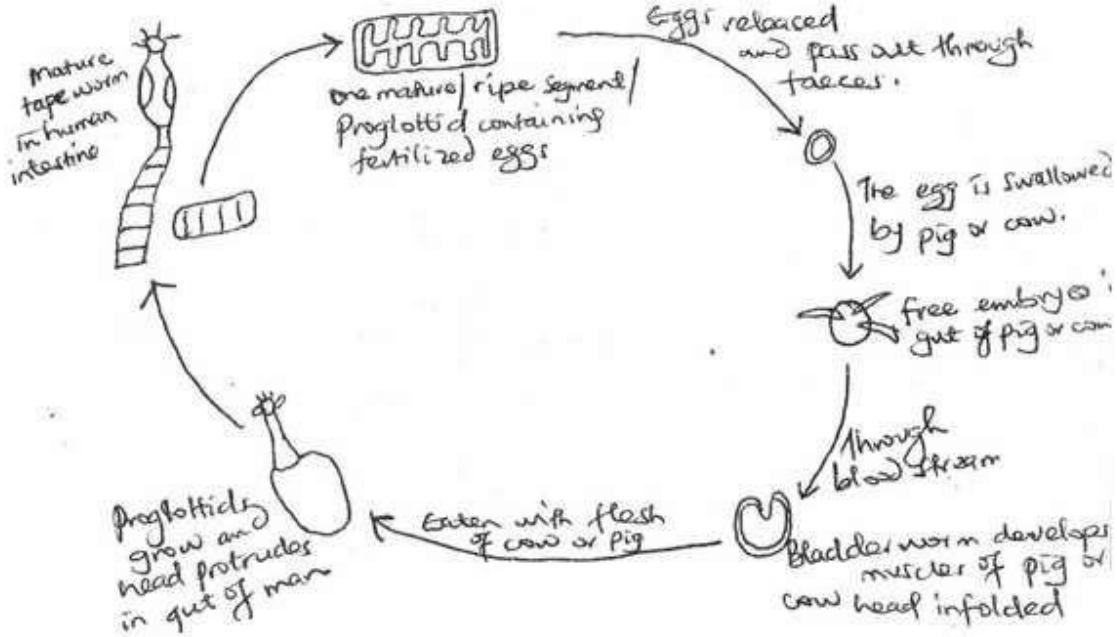
The body is dorso-ventrally flattened and consists of segments called **proglottids.** The progottids are reproductive organs because they contain fertilized eggs. The segments break off and pass out in faeces.



LIFE CYCLE OF ATAPE WORM

Life cycle (description)

Within the infected human being, the mature proglottids containing fertilized eggs breaks off from the adult warm and passes out in feces .These rapture and release eggs called **oncosphere.** The eggs are eaten by the pig or cows and are developed into embryo in the gut or intestine of pigs. The embryo burrow through the intestine walls into blood streams and are transported to muscles. An infected cow or pig is eaten, the bladder worms are released into the intestines where they develop into tape warms.



Cattle or pig is the primary host while man is the secondary host.

ADPTATION OF TAPE WORMS

(i) The have hooks and suckers on their head for attachments to the intestinal walls of their host.

(ii) They have flattened bodies that offer a large surface area for absorption of food.

(iii) They produce many eggs and have a high reproductive rate which increases their chances of survival. iv. They can respire anaerobically and are thus able to survive in the low oxygen concentration in the hosts gut.

(iv) They are hermaphrodites and self-fertilizing

(v) They have a thick cuticle, secrete a lot of mucus and anti-enzymes substances that protect them from being digested by the host's enzymes.

(vi) They lack the alimentary canal hence absorb already digested food over the entire body surface by diffusion. viii. They have intermediate hosts that enhance the efficiency of transmission from one primary host to another.

CONTROL OF TAPEWORMS

- Avoid eating raw or half cooked meat i.e eat properly cooked meat.
- Regular deworming of infected individuals.
- Proper disposal of water /feces/sewage.
- Inspection of meat before it is considered fit for human consumption

PHYLUM NEMATODA

These are the nematodes (**round worms**)

Characteristic features

- They have elongated, cylindrical bodies pointed at both ends
- They have bilateral symmetry
- They are triploblastic
- They are an unsegmented
- They have a complete digestive system with a mouth and anus
- They have separate sexes
- Their bodies are covered with a thick cuticle
- Lack a true coelom
- Lack both cilia and flagella
- Some are free living while others are parasitic Examples are
  - ✓ Filarial worms which cause elephantiasis
  - ✓ Round worms (*Ascaris Lumbricoides)*
  - ✓ Hook worms
  - ✓ Guinea worms

PHYLUM ANNELIDA (segmented worms)

Characteristics

- They have segmented bodies (have metameric segmentation)
- They are triploblastic
- They are coelomate (have a coelom)
- They have bilateral symmetry

- The gut is separated from the body wall
- They have cylindrical bodies with both longitudinal and circular muscles
- They have a well-developed nervous system ➢ They have no cuticle
- Their segments have **chaeta** for locomotion
- They have nephridia for excretion and osmoregulation

Examples include earth **worms lug worms, rag worms, and leeches**

Phylum annelida is divided into three main classes;
Class **polychaeta, oligochaeta and hirudinea**

Class Polychaeta (marine worms)
Characteristics
- They are marine worms
- They have numerous chaeta formed lateral extensions called parapodia
- They have a distinct head
- Have no clitellum

Examples are **the rag worms** and **lug worms**

Class Oligochaeta
They have no distinct head
They have few chaeta in pairs
Lack parapodia
Have clitellum (swollen structure) where the eggs are formed
They are hermaphrodites
An examples is Lumbricus (**earthworm**)

Class Hirudinea
- They have no chatea or parapodia
- They have no clitellum
- They are ectoparasites or predators

An example is the **Hirudo (medicinal leech)**

PHYLUM MOLLUSCA
These are the molluscs
Characteristics
- They have soft bodies
- Their bodies are covered by shells containing calcium (calcareous shell)
- They are unsegmented
- These are triploblastic
- They are coelomate (have body coelom)
- They have bilateral symmetry
- Their main body cavity is a haemocoel

- Their blood contains haemocyanin pigment which contains copper making blood green ➢ Some are aquatic while others are terrestrial.

Examples include **snails, slugs, squids, and octopus**

PHYLUM ECHINODERMATA

These are the echinoderms

Characteristics

- They have a spiny skin
- They have a five way radial symmetry (pentamerous symmetry) i.e they can be divided into 5 equal parts
- They are unsegmented
- They have a star shape
- The mouth generally occurs on the lower side (oral side) while the anus occurs on the upper side (literal side)
- They have no excretory organs
- They are exclusively marine
- They have a calcareous skeleton

Examples include; **star fish, sea urchin, bristle star, sea cucumbers, and sand dollars**

PHYLUM ARTHROPODA

These are the arthropods. They are the most diverse organisms with over a million species.

Characteristics

- **They have jointed appendages**
- **They have segmented bodies**
- **They have an exoskeleton made of chitin**
- They have bilateral symmetry
- They are triploblastic
- They are coelomate (coelomis greatly reduced and the main body cavity is called haemocoel filled with blood)
- They have a well-developed nervous system

NB. The first three features are the diagnostic features used to identify arthropods

Classification of phylum arthropoda

Phylum arthropoda is divided into five classes

- Class insect
- Class crustacean
- Class arachnida
- Class chilopoda
- Class diplopoda

Class Crustacea

Characteristics

- Have two main body parts
- They have two pairs of long antennae
- They have one pair of compound eyes
- They have three pairs of mouth parts (jaws)
- They are mainly aquatic esp in marine waters
- Gaseous exchange occurs by gills

Examples include **crab, lobster, wood lice, shrimps, prawns**, cray fish, daphnia (water fleas)

Class arachnida

- They have two main body parts (cephalothorax and abdomen)
- They have four pairs of jointed legs
- They have no antenna
- They have simple eyes
- They are mainly terrestrial
- They breathe through book lungs which are modifications of gills Examples are **ticks, mites scorpions, spiders**

Class Chilopoda

These are the **centipedes**

- They have cylindrical body with many segments
- Each segment has a pair of legs ➢ They have one pair of antennae
- They are mainly terrestrial
- They have one pair of mouth parts (jaws)
- They are mainly carnivores
- They have a distinct head
- They have no eyes
- Gaseous exchange occurs by trachea

Class Diplopoda

These are the **millipedes.**

Characteristics

- They have a long cylindrical body with amny segments
- Each segment has two pairs of legs
- They have one pair of antenna e on the head
- They have no eyes
- They are mainly herbivorous
- They are terrestrial
- They have a distinct head
- They have one pair of mouth parts
- No larval forms
- Gaseous exchange by the trachea

Class insecta

Insects form the most diverse class of arthropods found almost in every habitat. They are the only invertebrtares which can fly.

Diagnostic characteristics

- They have three main body parts (head, thorax and abdomen
- They have three pairs of jointed legs
- They have three thoracic segments (prrothorax, mesothorax and metathorrax) **Other characteristic features**
- They usually have a pair of antennae on the head
- A pair of compound eyes usually
- They have simple eyes
- Mainly terrestrial
- Usually three pairs of mouth parts
- Gaseous exchange occurs by trachea
- Lifecycles commonly involve metamorphosis

LIFE HISTORY OF INSECTS

Insects have a general trend of life which starts by laying eggs by a female insect. The eggs are fertilized internally. The eggs later change to other stages involving change in form and structure in a process called **metamorphosis.**

Metamorphosis is defined a series of marked changed during development from the larva stage to adult stage.

There are two types of metamorphosis

(i) Holometabolous/complete metamorphosis; involves four distinct stages i.e egg, larva, pupa and adult. The larval stage looks entirely different from the adult stage, which is specialized for dispersal and reproduction. Larval stages are specialized for eating and growing and are known by such names as caterpillar, maggot, or grub.

(ii) Hemimetabolous/incomplete metamorphosis; involves three stages i.e egg, nymph and adult. The eggs hatch into nymphs which resemble adults but are smaller and lack wings. The nymph undergoes a series of molts, each time looking more like an adult. With the final molt, the insect reaches full size, acquires wings, and becomes sexually mature.

CLASSIFICATION OF INSECTS

Insects are classified into two subclasses depending on the presence or absence of wings. Insects which have wings are called **pterygotes** (subclass pterygota) while those without wings are called **apterygotes** (subclass apterygota)

Subclass Apterygota (apterygotes)

These are wingless insects. This subclass has the following orders

- Order protera
- Order diplora
- Order colembora

- Order thysanura

Subclass Pterygota

These are winged insects. They are divided into **endopterygota** and exopterygota.

In exopterygota, wings develop externally and they undergo incomplete metamorphosis (hemimetabolous)

Orders include;

- Order dictyoptera e.g cockroach
- Order isopteran e.g termites
- Order orthoptera e.g grasshopper
- Order hemiptera e.g bed bugs
- Order odonata e.g dragon flies

In **endopterygota,** wings develop internally and they undergo complete metamorphosis (holometabolous)

Orders include;

- Order diptera e.g housefly
- Order hymenoptera e.g bees
- Order Lepidoptera e.g butterfly
- Order coleoptera e.g beetles
- Order siphonoptera e.g fleas
- Order anoplura e.g lice

The table below summarises the different orders under class insecta

	Order	**Characteristics**	**Examples**
Exopterygotes and hemimetabolous	Hemiptera	➢ Piercing and sucking mouth parts ➢ Two pairs of wings (wings maybe vestigial and absent in some) ➢ Incomplete metamorphosis	True bugs (stink bugs, bed bugs, aphids, water bugs, planthoppers, scale insects
	Odonata	➢ Long slender abdomen ➢ Chewing mouthparts ➢ Two pairs of wings. These are thin and transparent ➢ Wings are held above the body at rest ➢ Large eyes on the head ➢ They possess very small antennae ➢ Legs cannot walk but are used to capture prey in air ➢ They mate in flight ➢ Incomplete metamorphosis	Dragon flies, damsel flies

	Orthoptera	➢ Long cylindrical body ➢ Have mandibles for biting and chewing ➢ Two pairs of wings ➢ Large compound eyes ➢ Well-developed hind legs for jumping. Legs have spines for protection ➢ Anal cercus modified into an ovipositor ➢ Incomplete metamorphosis	Grasshoppers, locusts, crickets
	Dictyoptera	➢ Dorso-ventrally flattened body ➢ Two pairs of wings ➢ Mandibles for biting and chewing ➢ Well-developed anal cercus ➢ A pair of long antennae ➢ Incomplete metamorphosis	Cockroaches, preying mantis
	Isoptera	➢ Mandibles for biting and chewing ➢ Have equal sided wings ➢ Workers and soldiers are wingless ➢ Are social insects ➢ Incomplete metamorphosis	Termites, white ants
Endopterygotes and holometabolous	Diptera	➢ One pair of wings; the second pair has become modified into halters for balancing ➢ A pair of large compound eyes ➢ Proboscis for piercing and sucking ➢ Complete metamorphosis	Houseflies, mosquitoes
	Coleoptera	➢ Two pairs of wings ➢ Hard outer wings called elytra for protection ➢ Mouth parts modified for biting and chewing ➢ Complete metamorphosis	Beetles, weevils
	Hymenoptera	➢ Two pairs of membranous wings ➢ Chewing mouth parts ➢ Worker ants and few others are wingless ➢ Complete metamorphosis	Bees, wasps, saw flies, red ants
	Lepidoptera	Possess to pairs of broad wings covered ➢ with scales ➢ Long proboscis for sucking ➢ A pair of long antennae ➢ The front wings are usually larger than the hind wings ➢ Complete metamorphosis	Butterfly, moth

	Siphonoptera	➢ They are wingless ➢ Piercing and sucking mouth parts ➢ They lack eyes ➢ Complete metamorphosis	Fleas

SUCCESS OF INSECTS Insects form the most diverse and most successful group of organisms.

The factors which have led the success of insects include the following

1. They are small in size and this has enabled them to occupy small space and live in a variety of habitats.
2. They have a hard exoskeleton made of chitin which protects them from mechanical injury
3. They have a waxy cuticle which prevent excessive water loss hence they can retain water even under dry conditions
4. They excrete uric acid as a nitrogenous waste product. Uric acid is insoluble and non-toxic hence requires no water to remove from the body. This has enabled insects to conserve enough water in their bodies. enabled them to maintain high numbers
5. They lay many eggs and have a high reproductive rate which has
6. Most of them have wings for flying from one place to another to look for food and escape predators
7. They have a tracheal system which ensures efficient gaseous exchange
8. They feed on a variety of food and therefore cannot starve which increases their chances of survival
9. They possess a variety of colours for camouflage to avoid predators
10. Some have compound eyes for wide vision

ECONOMIC IMPORTANCE OF INSECTS

1. They pollinate flowers e.g bees and butterflies
2. Some insects are eaten by man as food e.g grasshoppers. Insects are also food to many other organisms hence maintaining the ecosystem stable
3. Bees provide honey which is eaten by man, medicine and provides wax for making candles 4. Some insects are vectors for a number of diseases e.g mosquitoes, houseflies, tsetse flies etc.
5. Some insects are pests and destroy man's crops e.g locusts. Some larva stages of insects e.g caterpillar also destroy crops
6. Some insects are parasites to man leading to irritation and discomfort e.g bed bugs and fleas
7. Some species of butterflies produce silk used in the making of cloth
8. Butterflies are also used for decoration because of their beautiful patterns and colour of the wings

PHYLUM CHORDATA

Organisms in this phylum are called chordates. It includes all the vertebrate, tunicates and lancelets.

They have the following characteristics

Diagnostic features

(i) They have a notochord at some stage in development. This is a small flexible rod made from cells from the mesoderm. It is between the dorsal nerve and the gut. It appears in embryos and is retained in some chordates. In vertebrates it is later replaced by the vertebral column/back bone

(ii) They have a dorsal hollow nerve cord which develops into the central nervous system (brain and spinal cord). Other animal phyla have solid nerve cords, and in most cases they are ventrally located

(iii) They have gill slits in the pharynx (Pharyngeal gill slits/visceral clefts). These are perforations on either side of the pharynx which occurs in chordate embryos. They connect the mouth to the throat. In fish and larval amphibians, these become gills for gaseous exchange. In other chordates, they are reduced or modified.

(iv) They have a post anal tail at some stage during development. The post anal tail extends posterior to the anus. This may be reduced or lost in some adult chordates.

Other characteristics

(v) Segmented muscle blocks called myotomes on either side of the body

(vi) Closed circulatory system

(vii) They have an endoskeleton made up of bones and cartilages

(viii) Show bilateral symmetry

(ix) They are triploblastic

(x) They are coelomate/have a coelom

Phylum Chordata is divided into three subphyla

- **Urochordata.** These are tunicates and include the sea squids. They lose chordate characters in the adult stage
- **Cephalochordata**. these are the **lancelets** e.g amphioxus **Vertebrata**. These are the vertebrates

Urochordata and cephalochordata have very few species. These are invertebrate animals but show characteristics of chordates. They retain the notochord in adult stage (notochord not replaced by a vertebral column). They don't have a skull and they are generally referred to as **acraniata.**

Vertebrata (vertebrates)

These are chordates in which the notochord has been replaced by the backbone (vertebral column) made of bones and cartilages. Their brain is enclosed in a skull/cranium, hence the name **craniata**

Vertebrates are divided into five major classes

- Pisces
- Amphibia
- Reptilia
- Aves
- Mammalia

CLASS PISCES (fish)

✓ Their bodies are covered with scales

- ✓ They have fins for swimming
- ✓ They have a lateral line for detecting vibrations in water
- ✓ They have a two chambered heart
- ✓ They use gills for gaseous exchange
- ✓ They lay eggs which are fertilized externally
- ✓ They have a streamlined body
- ✓ They are aquatic
- ✓ They are ectothermic/poikilothermic

Class pisces is divided into two subclasses; **chondrichthyes and osteichthyes**

Subclass chondrichtyes (cartilaginous fish/elasmobranchs)

- ➢ They have a skeleton made of cartilage
- ➢ They have five pairs visible gill slits
- ➢ Their gills have separate openings
- ➢ They have no operculum
- ➢ No external ears
- ➢ They have paired pectoral and pelvic fins
- ➢ Their fins are fleshy
- ➢ The tail is asymmetrical i.e have a heterocercal tail for balancing to prevent sinking
- ➢ They have no swim bladder
- ➢ The mouth is ventral
- ➢ They have placoid scales (tooth like scales embedded in the skin0 ➢ They are poikilothermic
- ➢ They are marine dwellers.

Examples include; sharks, rays, dog fish, and skates.

Subclass osteichthyes (the bony fish/teleosts)

- ➢ They have a skeleton made of bones
- ➢ They have bony scales
- ➢ They have four pairs of gill slits
- ➢ They have an operculum covering the gills
- ➢ They have a swim bladder
- ➢ They have a symmetrical tail i.e homocercal tail
- ➢ Have a terminal mouth
- ➢ Have fins supported by rays
- ➢ They are mainly fresh water dwellers but some are marine

Examples include; **tilapia, nile perch, mud fish, cat fish, silver fish**

Question. State the differences between bony fish and cartilaginous fish

CLASS AMPHIBIA

- ➢ They have a moist skin with glands

- They have four pentadactyl limbs
- They have webbed on the hind limbs feet
- They have a three chambered heart with one ventricle and two atria
- They lay eggs in water which are fertilized externally
- The body is divided into head and trunk
- They use gills for gaseous exchange in larva stage and lungs, moist skin and lining of buccal cavity in adult stage
- Have protruding eyes
- Have no external ear lobes
- Have a bony endoskeleton
- They undergo metamorphosis in their life cycle ➢ They are ectothermic

Examples include; **frogs, toads, newts, salamanders**

NB. Amphibians were the first chordates to colonise land and can live on both land and water. They are not fully adapted to terrestrial life.

Larval forms (tadpoles) spend their life in water while adults live on land

CLASS REPTILIA (reptiles)

- They have a dry skin covered with bony scales
- They lay eggs which are fertilized internally
- They have soft shelled eggs
- They use lungs for gaseous exchange
- They have two pairs of limbs except a few which have no limbs e.g snakes
- They are mainly terrestrial although some live in water
- They have a bony endoskeleton skeleton
- Have homodont teeth (same type)
- They are poikilothermic

Examples include; **crocodiles, lizards, snakes, alligators, geckos, chameleon, tortoises, turtles** etc

CLASS AVES (birds)

- Their bodies are covered with feathers
- They have a horny beak with no teeth
- They have scales on their legs
- They have a keel-like extension of the sternum
- They lay eggs with hard shells
- They undergo internal fertilization
- They have hollow bones
- Their fore limbs are modified into wings
- They have a four chambered heart
- They have lungs for gaseous exchange
- They have a complete circulatory system
- They are endothermic/homoeothermic

- They are terrestrial

Examples include; **doves, hens, eagles, flamingoes, ostrich, penguins, owls** etc

CLASS MAMMALIA

These are the mammals. They are the highest and most developed group of the animal kingdom because they have the ability to learn with a high degree of intelligence. The distinctive character from which mammals derive their name is their mammary glands, which produce milk for offsprings.

Characteristics

- They have mammary glands that produce milk
- Their bodies are covered with hairs /fur
- They have external ear lobes/pinnae
- They give birth/produce young ones alive (they are viviparous) except a few which lay eggs
- They have lungs for gaseous exchange
- They have a four chambered heart
- They have heterodont teeth /differentiated teeth that differ in shape and function
- They have visceral clefts and they never develop into wings
- They have a well-developed brain (mammals generally have a larger brain than other vertebrates of equivalent size, and many species are capable learners)
- They undergo internal fertilization
- They are homeothermic

Mammals are divided into three groups and these are;

- Placental mammals (eutherians)
- Marsupials/pouched mammals (metatheria)
- Egg laying mammals (prototheria)

The egg laying mammals (prototheria)

These lay eggs. Most of the animals in this group are extinct. The only living are the **monotremes**. They are represented by **duck-billed platypus** and **spiny anteaters** which are found only in Australia and New Guinea.

They produce milk, but they lack nipples. Milk is secreted by glands on the belly of the mother. After hatching, the baby sucks the milk from the mother's fur.

Marsupials/pouched mammals (metatheria)

These are mammals which have a pouch called marsupium. They produce immature young ones which are then kept in the mothers pouch and are fed on milk. While in the mothers pouch, they complete their development

Examples of marsupials are **Opossums, kangaroos, and koalas, marsupial moles**

Placental mammals (eutherians)

These are higher mammals where the embryo develops within the uterus joined to the mother by the placenta. After birth, the young ones survive on breast milk by suckling from the mother. They

maintain an intimate and long lasting association with their young ones. This is where we (humans) belong.

Subclass eutharia (placental mammals) is divided into the following orders

(i) Order insectivore. These are mammals which feed on insects e.g shrew, moles
(ii) Order rodentia. They have chisel shaped incisor and are gnawers e.g rats, squirrels, rats, mice, porcupines
(iii) Order carnivora. These are flesh eating mammals. They have sharp pointed canine teeth for tearing e.g lion, tiger, leopard, dogs, cats, wolves etc
(iv) Order ungulate. These are herbivores (feed on plant materials).they have hooves with an even number of toes on each foot. e.g cattle, sheep, goats, horses , giraffes,
(v) Order cetacea . these are aquatic mammals e.g dolphins and whales, porpoises
(vi) Order chiroptera. These are the flying mammals which includes bats
(vii) Order legomorpha. Hind legs longer than fore legs for jumping. Have chisel-like incisors, are herbivores e.g rabbit (viii) Order primates.

Order primates

- Primates are the most advanced of all the animals.
- They have the largest brain and have a good memory
- They have a well-developed cerebral cortex
- Most primates have hands and feet adapted for grasping
- Their digits have flat nails instead of the narrow claws of other mammals
- They have a movable thumb (**opposable thumb**) separate from the fingers
- They have forward-facing eyes
- They have short jaws, giving them a flat face.
- They have complex social behavior.
- They are omnivorous

Examples of primates include e.g apes, monkeys, chimpanzee, humans, lemurs etc.

Geog 1

SENIOR FIVE GEOGRAPHY PAPER 1 (MR.KIBUUKA VICENT)

FACTORS INFLUENCING THE CLIMATE OF E.AFRICA

The climate of E.Africa varies from one region to another ranging from Equatorial to Tropical, Semi arid and MoS5ntane climate although the region is located across the equator.

The variations in E.Africa's climate are as a result of the following factors: a. Altitude

It refers to the height of the land above sea level. High altitude areas especially highlands like Mt Rwenzori, Mt Elgon, Mt Kenya and Mt Kilimanjaro experience cool temperatures because temperatures decrease with increase in altitude and heavy rainfall ranging between 1000-1500mm resulting into montane climate. Cool temperatures in high altitude areas are due to the effect of the environmental lapse rate i.e For every 1000metres of ascent, temperatures fall by

6.5^{o}c. Equally, high altitude areas experience low pressure because pressure reduces with an increase in altitude. It is also due to a small column of air pressing down on the earth's surface. High altitude areas experience low humidity due to the cool temperatures

On the other hand, low altitude areas such as the rift valley region, the foothills of mountains and coastal areas experience hot temperatures due to intense heating by both solar and terrestrial radiation as well as the excessive impurities in the air such as dust particles, water molecules and carbondioxide which absorb heat that is radiated in the low altitudes. This explains why Mombasa is hotter than Nairobi. Low altitude areas experience high pressure because pressure increases with a decrease in altitude. This is also because of a big column of air pressing over the earth's surface. Low altitude areas such as the Nyika plateau in Kenya are dry, receiving rainfall of less than 700mm. Low altitude areas experience high humidity due to the high rates of evapotranspiration as a result of hot temperatures b. Latitude

It is the angular distance of an area as measured from the equator. E.Africa lies astride the equator. Its location explains the generally hot temperatures experienced throughout the year. Areas near the equator experience hot temperatures, heavy rainfall with a bi modal (double rainfall pattern), low atmospheric pressure and high humidity due to the effect of the overhead sun twice a year leading to equatorial climate e.g around the lake Victoria basin.

On the other hand, areas far from the equator such as Northern Uganda and

Southern Tanzania experience cool temperatures as well as wet and dry conditions

(mono modal/single rainfall pattern) because the sun's rays are scattered (spread) over a wide area and reach the earth's surface at acute angles causing less heating. Temperate and polar areas experience temperate climate due to their far distance from the equator

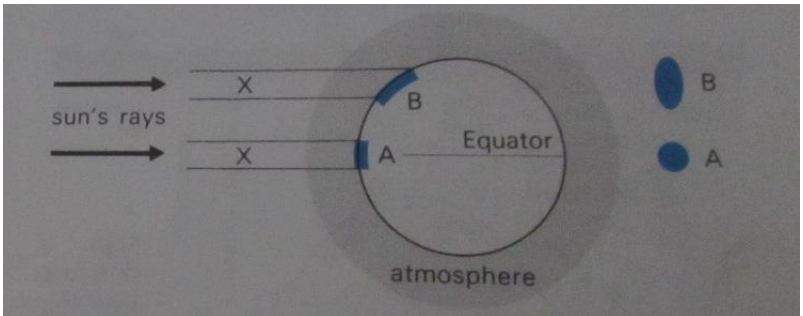


Fig. 14.2 More insolation reaches the earth's surface when the angle of the sun's rays is 90° than when it is less than 90°. The sun's rays pass through a greater thickness of atmosphere to reach B than to reach A. You can see that the surface area of B is oval-shaped and is larger than the surface at A.

c. Relief

It refers to the physical appearance of the landscape in an area. Highland areas such as Mt Rwenzori, Mt Kenya and Mt Kilimanjaro experience heavy rainfall and cool temperatures on the wind ward sides while dry conditions are experienced on the lee ward sides. This is because mountains act as barriers towards the movement of moist winds thereby forcing them to rise upwards to the condensation level leading to rainfall on the wind ward side while the descending dry winds resulting into dry conditions on the lee ward side. For instance Masai land in Tanzania lies on the lee ward side of Usambara and Pare mountains.

Lowland areas on the other hand experience low and un reliable rainfall due to the absence of relief barriers to trap the moving moist winds in areas such as

Turkanaland in Northern Kenya, Karamoja in North eastern Uganda and the Albert flats

d. Continentality (Distance from the sea)

Areas near the sea (water bodies) such as the coastal areas of E.Africa and lake Victoria basin experience heavy rainfall due to the effect of land and sea breezes. The sea breeze occurs during day time where cold moist air moves from the sea towards the adjacent land while the land breeze occurs at night involving cold moist winds from the land blow towards the sea. This modifies the temperatures over the land and the sea respectively thereby causing the formation of convectional rainfall as warm air rises towards the condensation level.

Water bodies also recharge the atmosphere with moisture through evaporation resulting into heavy rainfall in the adjacent areas e.g the lake Victoria basin. Areas far away from water bodies like North eastern Uganda and Central Tanzania are hot and dry due to the absence of water bodies

e. Prevailing winds

They are defined as local winds which blow from sub tropical areas of high pressure into areas of low pressure in the tropics.

The winds are either moist or dry, cool or warm thus influencing the rainfall and temperature conditions of the areas where they flow to. The climate of E.Africa is mainly influenced by three (3) trade winds i.e The North east trade winds, South east trade winds and the westerlies.

The North east trade winds originate from the Arabian desert. They are therefore dry. As they blow towards E.Africa, they pick moisture from the Red sea which is later lost on the wind ward slopes of the Ethiopian highlands. The winds later continue into E.Africa as cool dry winds causing low rainfall and low humidity in areas like North eastern Uganda, North western Kenya as well as Northern Kenya in general hence semi arid climate.

The South east trade winds originate from the Indian ocean hence they are moist. They flow towards the E.African coast thereby causing heavy rainfall and high humidity. They later continue on their eastward journey towards the interior of E.Africa as dry winds causing dry conditions in Central Tanzania. They are later recharged with moisture after crossing lake Victoria consequently causing heavy rainfall on the northern and north eastern shores of lake Victoria but leaving Ankole Masaka corridor dry.

The westerlies originate from the Atlantic ocean with a lot of moisture from the sea. They blow over the Congo basin leading to heavy rainfall on the western slopes of

Mt Rwenzori. They however continue towards the lee ward slopes with areas like Kasese and the rift valley region of western Uganda as dry winds leading to semi arid climate

f. Ocean currents

They are defined as large scale movements of surface water in an ocean/sea within a defined direction.

Ocean currents are either warm or cold hence they influence the temperature and rainfall conditions of the coastal areas. The warm ocean currents such as the Mozambique current cause hot temperatures and heavy rainfall around the coastal areas of E.Africa e.g The equatorial climate between Mombasa and Dar es Salaam is due to the effect of the warm Mozambique current.

Cold ocean currents such as the Benguela current lead to low temperatures, low humidity and low rainfall in coastal areas such as Namibia

g. Coastal configuration

The alignment of the E.African coast in the North east to South west direction forces the prevailing winds and ocean currents to flow or move parallel to the coast. This leads to low humidity and low rainfall in areas like North eastern Kenya hence semi arid climate because the moisture carried by the prevailing winds and ocean currents is not deposited at the adjacent areas

h. Perturbation

This refers to the formation of a low pressure belt over the Indian ocean due to hot temperatures. Winds are therefore drawn from the interior of E.Africa towards the Indian ocean causing heavy rainfall over the ocean while leaving the coastal areas dry. The semi arid climate in North eastern Kenya is as a result of the perturbation effect

i. Rotation of the earth (Corriolis force effect) According to Ferrel's law, any loose object or body such as a wind in the northern hemisphere flowing over the earth's surface is deflected to the right of its path after crossing the equator. The South east trade winds are therefore deflected to the right causing heavy rainfall (equatorial climate) on the northern shores of Lake Victoria and dry conditions (semi arid climate) in the Ankole Masaka corridor. Winds blowing across Kenya from the south are deflected to the Indian Ocean causing rainfall over the sea and dry conditions in North eastern Kenya

j. Vegetation cover

Forested areas such as Mabira, Budongo and Bugoma experience heavy rainfall, high humidity and moderate temperatures. Areas with limited vegetation cover on the other hand experience low rainfall totals, low humidity and hot temperatures in areas like Turkana land and Ankole Masaka corridor

k. Human activities A variety of man's activities like deforestation, swamp reclamation, bush burning, overstocking and over grazing result into reduced rainfall amounts and hot temperatures. That is why semi arid climate is experienced in North eastern Uganda, North western Kenya and in some parts of Central Tanzania.

On the other hand, man's activities such as afforestation and re afforestation have restored vegetation cover resulting into increased rainfall amounts in areas such as

Mt Elgon slopes, Kigezi highlands and Kenya highlands

Qn. To what extent has altitude influenced the climate of E.Africa?

TEMPERATURE

It refers to the measure of the degree of hotness or coldness of the atmosphere over a given place **OR** It is the amount of sensible heat or cold with in the atmosphere of a given area.

The major source of heat affecting the atmosphere and the earth's surface is solar radiation which is defined as the heat emitted and transferred to the earth's surface by the sun.

However, heat is also transferred from the earth's surface into the atmosphere which is known as Terrestrial radiation.

The temperature of a place is measured using a sixth thermometer which records the maximum and minimum temperature of the day. When the highest and lowest temperature is obtained, the following expressions can be made:

- **Daily Temperature**

It refers to the actual amount of heat or cold that is recorded at a weather station in a day

- **Mean Daily Temperature**

It refers to the average of heat or cold that is recorded in a specific area in a day. ,It is obtained by;

$$\text{Mean Daily Temperature} = \frac{\text{Maximum Temperature + Minimum Temperature}}{2}$$

- **Daily (Diurnal) Temperature Range**

It refers to the difference between the highest and lowest temperature of the day

Daily Temperature Range = Highest Temperature – Lowest Temperature

- **Mean Monthly Temperature**

It is the average temperature of an area obtained when the sum of the mean daily temperature for a month is divided by the number of days in the month

$$\text{Mean Monthly Temperature} = \frac{\text{Sum of the Mean Daily Temperature}}{\text{Number of days in a month}}$$

- **Mean Annual Temperature**

It is the final figure obtained when the sum of the mean monthly temperatures in a year is divided by 12 months

$$\text{Mean Annual Temperature} = \frac{\text{Sum of Mean Monthly Temperature}}{12}$$

- **Annual Temperature Range**

It is the difference between the highest and lowest mean monthly temperature in a year **OR** It is the difference between the hottest month and the coolest month of the year Qn. Differentiate between diurnal temperature range and annual temperature range

FACTORS WHICH INFLUENCE THE TEMPERATURE OF AN AREA:

Different areas in E.Africa experience varying temperatures. Some areas experience extremely hot temperatures of over 30^{o}c. They include North eastern Uganda, Northern Kenya, the rift valley areas and the coastal areas.

Other areas experience very low / cool temperatures especially the mountainous or highland areas such as the Kenya highlands, Kigezi highlands, Mt Kilimanjaro, Mt Rwenzori, Mt Meru and Mt Elgon among others.

Several factors influence temperature or contribute to the variations in the temperature in E.Africa and they include:

a. Altitude

It refers to the height of the land above sea level. Temperatures tend to drop as altitude increases by approximately 6.5^{o}c for every 1000 metres of ascent / rise. Due to this lapse rate effect,

highland areas like Mt Rwenzori, Kenya and Kilimanjaro experience low temperatures while low altitude areas like the rift valley region experience hot temperatures

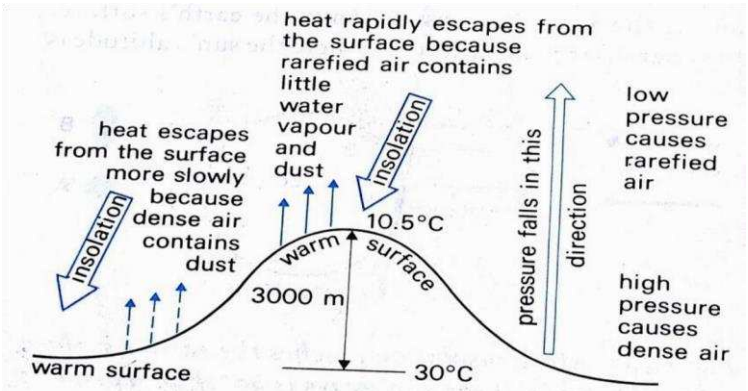


Fig. 14.3 A diagram to show the effect of altitude on temperature. What would the temperature be at the top of Mount Cameroon (4070 m) if the temperature at sea level were 30°C?

b. Latitude

It refers to the angular distance of an area from the equator. Temperatures tend to reduce as one moves away from the tropics towards the Polar regions. Given that E.Africa lies astride the equator, temperatures are uniformly hot with no big variations

c. Prevailing winds

They have a modifying effect on the temperature of the places where they blow depending on their origin. The North east trade winds which blow from the Arabian desert bring hot temperatures in North eastern Uganda (Karamoja) and Turkanaland while the Southeast trade winds and the Westerlies cause moderate temperatures around the Central plateau of E.Africa because they originate from the Indian ocean and the Atlantic ocean respectively

d. Continentality

It refers to the distance of a place from the sea. It is responsible for the variations in the temperatures between places near the coast and those in the interior. The South east trade winds transfer warm conditions to the coastal areas of E.Africa and this explains why Mombasa is relatively warmer than the interior of Kenya and E.Africa in general. Water bodies also have a modifying effect on temperature through the land and sea breezes

e. Vegetation cover

Thick vegetation cover has a modifying effect on the temperature of the surrounding areas through evapotranspiration. Forested areas have high humidity and relatively low temperatures for instance Mabira and Budongo forest. On the other hand, areas with limited vegetation cover tend to experience hot temperatures e.g North eastern Uganda and Turkana land in North western Kenya

f. Ocean currents

They are defined as streams of surface sea water moving on a large scale towards a defined direction. They are sub divided into two (2) categories i.e warm and cold ocean currents. They have a modifying effect on the temperature of the adjacent areas. Warm ocean currents such as the Warm

Mozambique currents raise the temperatures of the winds blowing around hence causing warm and/or hot temperatures to the adjacent lands such as Mombasa and Dar es Salaam g. Cloud cover

It also determines the temperature of a place. Thick clouds control the amount of solar insolation reaching the earth's surface and at the same time trap the escaping radiation from the earth's surface. For this reason, areas with thick cloud cover like the Lake Victoria basin experience a small diurnal range of temperature than areas like Turkana land with limited cloud cover

h. Apparent movement of the overhead sun

The position of the sun influences seasonal variations in temperature. Temperatures are higher in regions where the sun is overhead. When the sun is overhead in the northern hemisphere between June and July, hot temperatures are experienced in the northern hemisphere and low temperatures in the southern hemisphere. When the sun is overhead in the southern hemisphere in December and January, temperatures are high in the southern hemisphere and low in the northern hemisphere

i. Humidity

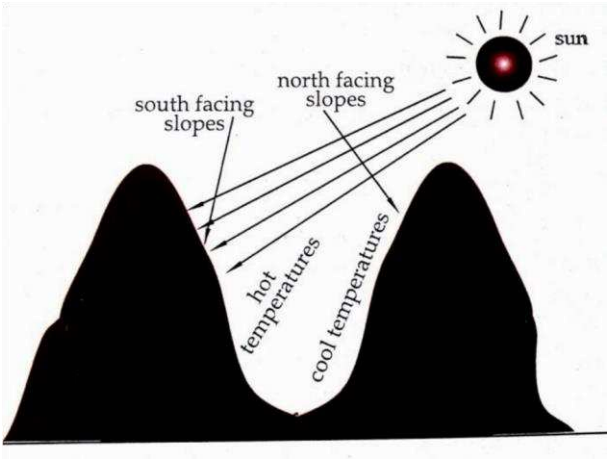
The amount of water vapour in the atmosphere determines the atmospheric temperature of a place. High amounts of humidity absorb heat and prevent heat loss from the earth's surface. This explains why areas with high humidity e.g equatorial regions experience hot temperatures during the day and at night than areas with low humidity which experience cool temperatures during the night due to excessive heat loss

j. Nature of the earth's surface (Albedo)

Surfaces covered by water or ice are bright so they reflect much of the heat (solar radiation) back into the atmosphere leading to low (cool) temperatures over the water surface during the day while solid dark coloured land surfaces absorb heat faster during the day leading to warm / hot temperatures

k. Aspect

It refers to the direction of a hill slope in relation to the position of the sun. It influences temperature in the temperate / polar regions where the south facing slopes in the northern hemisphere experience warm temperatures than the north facing slopes. In the southern hemisphere on the other hand, the north facing slopes are warmer than the south facing slopes. In the tropics however, the influence of aspect is not experienced due to the effect of the overhead sun



l. Human activities

The various activities of man such as deforestation, bush burning, overgrazing, mining and industrialization result into hot temperatures due to the destruction of natural vegetation, depletion of the ozone layer and the subsequent increase in carbonic emissions (gases) into the atmosphere which absorb solar radiation thereby causing hot temperatures. On the other hand, afforestation reduces carbon concentrations in the atmosphere since plants absorb carbondioxide leading to moderate temperatures.

Qn. Account for the variations in the temperature experienced in the different areas of E.Africa

ATMOSPERIC TEMPERATURE DISTRIBUTION

Temperature is distributed in the atmosphere in such a way that an increase in altitude leads to a fall in temperature i.e temperatures are warmer near the earth's surface (lower atmosphere) and lower in the upper atmosphere. As air rises, its temperature changes. This is referred to as adiabatic temperature change. The rate of decrease in temperature with increase in altitude is known as adiabatic lapse rate. The average rate of fall in temperature is 1^{o}c per 150metres of ascent or 6.5^{o}c per 1000metres of ascent. Temperatures fall with increase in altitude because of the following:

I. The air above the earth's surface expands over a wide space which leads to cooling hence low temperatures while air molecules near the earth's surface are compressed leading to high pressure and warm temperatures

II. The air above the earth's surface contains less impurities to absorb heat hence it is cooler than the air near the earth's surface with impurities such as dust particles which absorb heat

III. The amount of carbondioxide in the air is greater near the earth's surface than in the atmosphere and this causes temperature differences with variations in altitude

IV. The air above the earth's surface is far from the effect of terrestrial radiation hence it is cooler than the air near the earth's surface.

LAPSE RATE

It refers to the natural fall in temperatures with an increase in altitude **OR** a rise in temperatures with a decrease in altitude. As warm air rises, it expands and cools leading to a fall in temperatures. The increase in temperature or heat is caused by the compression of the air as altitude falls.

Types of Lapse Rate:

Lapse rate is described in three (3) ways:

a) Environmental lapse rate

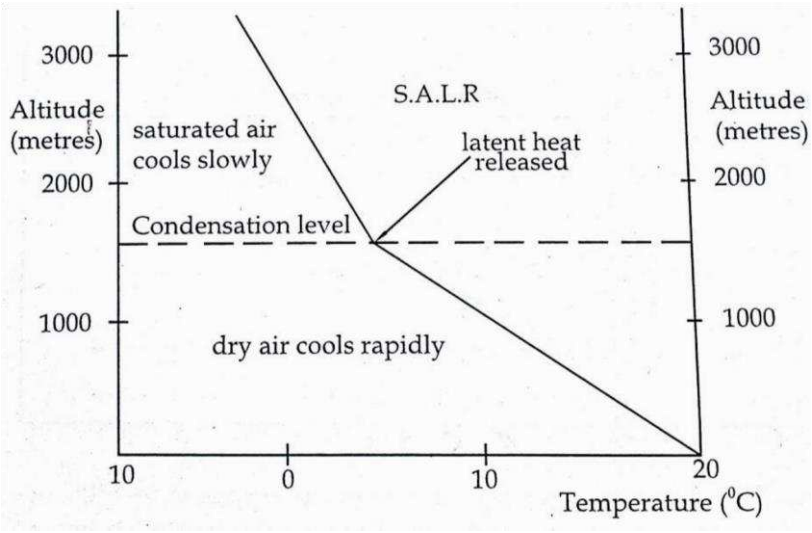
It is the rate at which temperatures change with an increase or a decrease in altitude. It is the vertical distribution of the temperature of a given geographical location at a particular period

b) Dry adiabatic lapse rate

It is the rate at which dry air cools as it rises without affecting the temperature of the surrounding atmosphere. Dry air cools at a faster rate of 1^{o}c per 100 metres of ascent

c) Saturated (Wet) adiabatic lapse rate

It refers to the rate at which air saturated with water vapour cools as it rises to greater heights (higher levels) of the atmosphere. Saturated (humid) air cools at a rate which is slightly lower than that of dry air i.e between $0.3^{o}c - 0.9^{o}c$ per 100metres of ascent.



Qn. Distinguish between **stability** and **instability** in the atmosphere

Stability in the atmosphere refers to a state of equilibrium reached in the atmosphere when a mass of dry air which is rising in form of a wind has a lapse rate that is greater than that of the surrounding air i.e the environmental lapse rate of an air mass is less than the dry adiabatic lapse rate.

The rising air mass loses its temperature ultimately becoming cooler and denser than the surrounding air mass. It then sinks back to the ground level unless when some external force is at work.

While;

Instability is a state of unstable equilibrium of the atmosphere where the environmental lapse rate of an air mass is greater than the dry adiabatic lapse rate. A surface pocket of un saturated air when heated, will rise and cool at the dry adiabatic lapse rate and because it is warmer than the surrounding air mass, it will continue to rise. Due to the fact that the surrounding air is denser than the rising air mass, it will force it up to greater heights where it cools from.

High instability leads to the formation of cumulo-nimbus clouds, stratus and cirrus clouds. The strato-cumulus and cumulo-nimbus clouds are associated with intense rainfall and thunderstorms.

The cirrus and stratus clouds give rise to clear skies / sunny weather conditions

The alto-cumulus and alto-stratus clouds give rise to light drizzles and unstable windy conditions

High humidity is formed with in the atmosphere

TEMPERATURE INVERSION

It is an atmospheric condition in which temperatures increase with an increase in altitude. In other words, the air at a higher altitude is warmer than the one in the valleys.

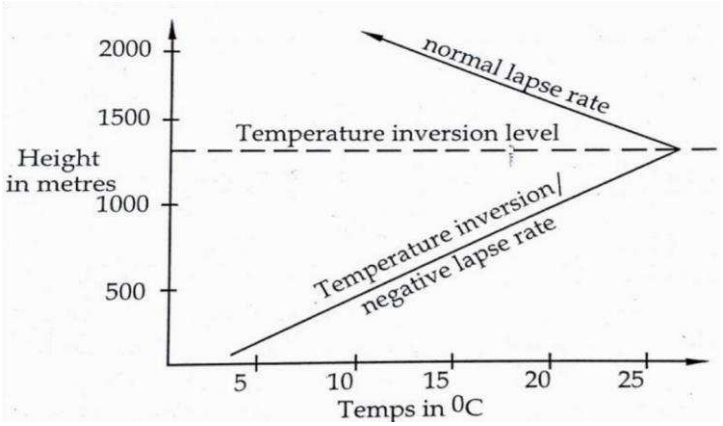
It is the opposite of the environmental or normal lapse rate where temperatures decrease with an increase in altitude.

Within the troposphere, an increase in temperature with altitude is up to a certain level referred to as the Temperature inversion level. Beyond this level, the normal lapse rate applies.

It is a temporary atmospheric condition which usually lasts for only a few hours especially in the morning time.

It normally occurs in highland areas due to temperature differences between the hill slopes and the valleys e.g In the Kigezi highlands, Kenya highlands as well as areas of limited cloud cover marked by air stability or calm weather. It also occurs in the semi arid areas.

It happens when surface air is cooled by the descending cold dense air while the warm light air is displaced upwards as illustrated below:

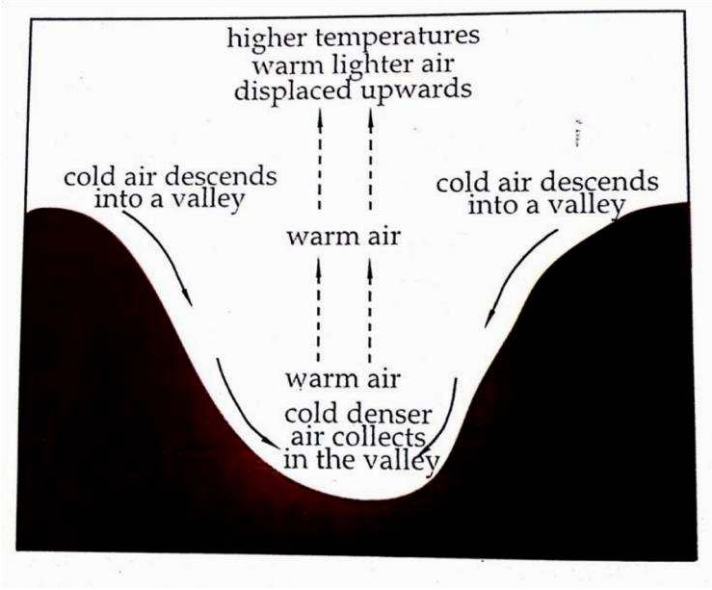


Causes of Temperature Inversion

1. Rapid radiation of the earth's surface during the night When there's limited or no cloud cover, the earth's surface cools faster at night due to the rapid loss of heat. At night, the earth is cooled as a result of the following:
   - The sky must be clear with no clouds to allow rapid loss of heat
   - The air must be static to ensure effective cooling
   - Longer nights to enable adequate time for cooling to take place This causes cooling of the air near the earth's surface hence causing low temperatures near the ground surface as compared to the air which is far above the ground surface.
2. Subsidence or sinking of cold dense air from the highlands to the valleys at night
   i.e the effect of the Katabatic winds

   Due to the rapid cooling of the upper slopes of highlands at night, air cools and becomes dense causing high pressure while the air in the valleys remains warm leading to low pressure. The cold dense air from the upper slopes therefore sinks downwards into the valleys displacing the warm air upwards hence causing temperature inversion e.g In the Kigezi highlands.

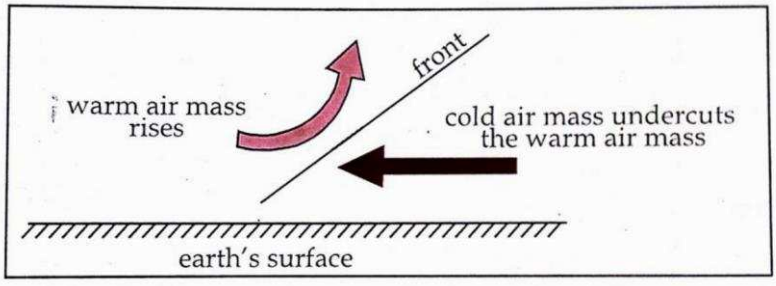
   N.B: **Katabatic winds** are defined as winds which blow from the hill slopes downwards into the valleys at night



3. Frontal convergence of warm and cold air masses

When two air masses with different temperature characteristics meet, the cold air mass which is dense sinks downwards and undercuts the warm light air mass. The cold air mass ultimately lies below the warm air mass leading to temperature inversion called frontal / cyclonic temperature inversion. This occurs in the tropics where air fronts are common i.e the Inter tropical frontal zones in E.Africa. It is also referred to as Frontal or cyclonic temperature inversion

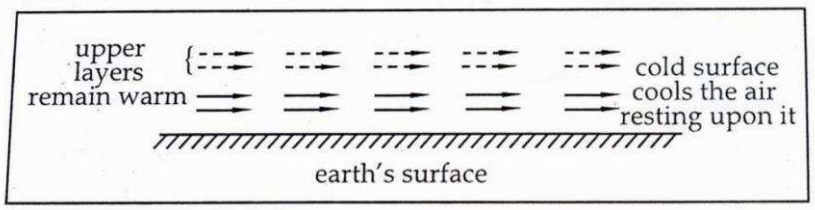
Illustration: Frontal temperature inversion



4. Advection

This is the horizontal movement and cooling of warm air blowing over a cold surface. This occurs when a mass of warm air horizontally blows over a cold surface. The cold surface cools down the lower layers of the air above it while the air far above remains warm. Temperatures will therefore become cold near the earth's surface and warm far above the ground surface. This is referred to as Advective temperature inversion. It eventually leads to the formation of advection fog

Illustration: formation of fog due to advection.



5. Movement of warm air into a cold region

Temperature inversion will occur when a warm air mass suddenly moves into a cold region where it is forced to rise upwards due to its lightness. As the warm air over rides the cold air, warm temperatures are transferred further to the cold region. This often occurs when warm trade winds blow into cold regions usually at a high altitude.

Effects of Temperature Inversion:

- It limits or retards the vertical movement of air currents leading to the creation of a stale atmospheric condition associated with limited rainfall
- It leads to premature surface condensation hence the formation of fog i.e tiny light water droplets which form over the earth's surface
- It leads to the formation of cold frosty conditions especially in the hilly areas due to the subsidence of cold dense air
- It promotes atmospheric pollution at higher levels especially in the industrial areas since the industrial carbons are easily spread by the warm air above the earth's surface
- The fog formed due to temperature inversion reduces visibility which affects the aviation and the transport industry in general thereby causing accidents
- The cold frosty conditions caused by temperature inversion discourage the growth of some crops such as tomatoes
- The cold frosty conditions which occur in the valleys due to temperature inversion favour the growth of some crops like pyrethrum, tea and sorghum as well as temperate crops like grapes and apples
- It leads to cold related diseases like asthma and pneumonia due to the cold conditions associated with it
- The fog experienced in the morning hours in areas such as Kigezi highlands due to temperature inversion reduces the morning working hours

Qn. Examine the causes and effects of temperature inversion in E.Africa.

TERRESTRIAL RADIATION

It is also known as **Thermal radiation**. It is defined as the energy transmitted or transferred from the earth's surface to the atmosphere. Radioactive decay of isotopes at the earth's surface contributes to the occurrence of terrestrial radiation

Terrestrial radiation is transferred in form of long waves(electro-magnetic radiation) and it occurs all the time both during day and night time in form of infra red energy i.e both light and heat energy

The amount of terrestrial radiation varies with the nature of the surface area and its size e.g water surfaces emit less radiation than land surfaces. Equally, mountain tops emit less radiation than the lowlands

The air, water vapour and clouds take up a great deal of this energy emitted by the earth thus resulting into the rising of temperature in the atmosphere which is measured and recorded at a weather station

Terrestrial radiation therefore results into **a rise in the temperature** of the atmosphere

SOLAR RADIATION

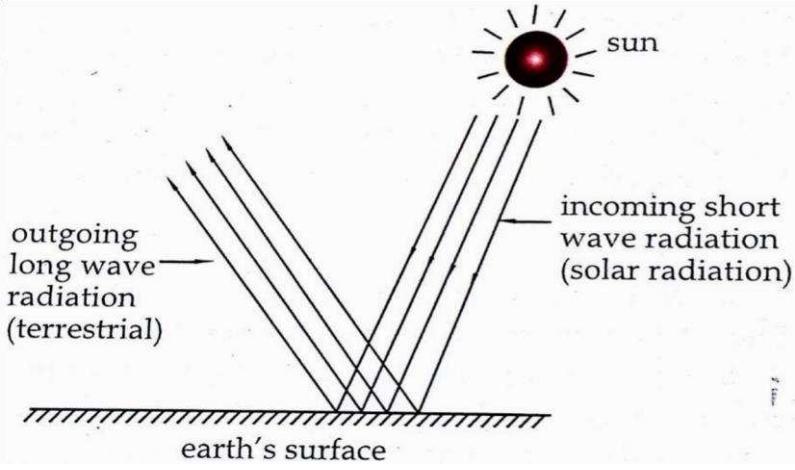
It refers to the energy transmitted from the sun to the earth through the atmosphere.

It passes in the atmosphere in form of a beam of short wave rays (solar short wave radiation)

Solar radiation is received in a place during the day in form of light and it is converted into heat at the earth's surface

The amount of solar radiation received in a place also varies from time to time. The air, clouds and the ozone in the atmosphere absorb some of this energy while dust particles and clouds reflect and scatter the energy into the space

The earth therefore absorbs only a fraction of the energy emitted by the sun. The nature of the earth's surface (Albedo) is used to express the ability of a surface to reflect insolation



Conditions Influencing the In-coming Solar Radiation In an area:

- Latitude

The angular distance of a place from the equator partly determines the distance from the sun to the earth's surface. This further determines the angle of incidence at which the sun's rays fall upon the earth's surface

Hence, there's always maximum insolation in the low latitudes because the sun's rays strike the earth's surface at right angles and have a short distance to travel through the atmosphere. There's intensive heating since there's a smaller surface area per ray. The sun's rays are however less intensive towards the mid latitudes and polar regions (high latitudes) because of the long distance they travel through the atmosphere and the oblique angle at which they strike the earth's surface

- Rotation of the earth

The rotation of the earth on its axis causes changes in solar radiation received in a place. Within the tropics when the sun is overhead, high amounts of solar radiation are received. Absence of the overhead sun at the poles, arctic and sub-arctic regions reduces the insolation rates

- Revolution of the earth

This causes seasonal variation in the amount of insolation received in the different places of the earth. More solar radiation is experienced during the summer season compared to the winter season

- Cloud cover

Clouds in the atmosphere absorb, reflect and refract insolation. This reduces the amount of solar radiation reaching the earth's surface hence implying that areas with thick cloud cover experience less solar radiation as compared to areas with clear skies

- Aspect

Areas in the direct path of the sun's rays especially in the mid and high latitudes receive more solar radiation as compared to those areas sheltered from the sun's rays. For instance, in the mid latitudes of the Northern hemisphere, the south facing slopes receive more solar radiation than the north facing slopes. This is because the south facing slopes are in the direct path of the sun's rays. The reverse is also true

- Humidity The amount of water vapour in the atmosphere may absorb or reflect solar radiation. It prevents some percentage of the solar radiation from reaching the earth's surface. Areas with a low humid content such as arid and semi arid regions on the other hand experience more insolation on their surfaces because direct heat from the sun is received

- Impurities in the atmosphere

Impurities such as smoke and dust particles tend to absorb part of the solar radiation reaching the earth's surface. This means that areas with a lot of atmospheric impurities receive less solar radiation as compared to areas with clear atmospheric conditions

- The sun's hot spots

The surface of the sun has certain sections which are hotter and emit more radiation. Therefore, sections on the earth's surface that receive heat directly from these hot spots experience greater solar radiation. The reverse is also true.

- Green house effect

The increase in the amount of green house gases like carbondioxide, methane, nitrous oxide, and carbon monoxide in the atmosphere affects the ozone layer hence triggering off the occurrence of global warming which ultimately increases the amount of solar radiation.

On the other hand, areas with limited atmospheric green house gases have an intact ozone layer hence they experience less solar radiation reaching the earth's surface Qn a) Distinguish between terrestrial radiation and solar radiation

b) Describe the conditions that influence the in-coming solar radiation in an area

HUMIDITY

It is the amount of water vapour held in a given volume of air at a given time. Atmospheric water vapour is as a result of evaporation and transpiration.

Humidity varies from place to place usually ranging between 48% to 80%. Water vapour is significant in the atmosphere because:

- It influences the formation of rainfall through condensation
- It regulates the temperature of the atmosphere through absorbing radiation i.e solar and terrestrial radiation
- It stores energy in the atmosphere

The humidity of a place can be described as follows:

- **Absolute humidity**

It is the actual amount of water vapour held by a given volume of air at a given temperature and time. Absolute humidity varies according to temperature and pressure. When air temperature reduces, water vapour condenses consequently lowering the humidity and when temperature rises, air is capable of holding more water vapour leading to high humidity

- **Relative humidity**

It is the actual amount of water vapour held by a given volume of air at a given temperature expressed as a percentage ratio of water vapour it is capable of holding **OR** It is the ratio of the actual amount of water vapour present in a given volume of air at a particular temperature to the amount of water vapour which the air can hold.

$$\text{Relative humidity} = \frac{\text{Actual amount of water vapour in a given volume of air}}{\text{Saturated water vapour content}} \times 100$$

OR

$$\text{Relative humidity} = \frac{\text{Absolute humidity}}{\text{Saturated water vapour content}} \times 100$$

Example:

If saturated air at $40^{o}c$ contains $40g/m^3$ of water vapour per $1m^3$, at a time of measurement the volume of air contains $20g/m^3$. Calculate the relative humidity.

Relative humidity = $\frac{\text{Absolute humidity}}{\text{Saturated water vapour content}} \times 100$

$= \frac{20}{40} \times 100$

Relative humidity = 50%

Factors which influence the Humidity of a place:

- Temperature

  Temperature controls or determines the rate of evaporation and transpiration. Hot temperatures lead to high rates of evaporation hence increasing the amount of water vapour in the atmosphere while cool temperatures reduce evaporation rates resulting into minimum condensation hence lowering the humidity of a place

- Altitude

  Since temperatures decrease with increase in altitude, high altitude areas like mountain tops experience low humidity as water vapour condenses while areas of low altitude like the coastal areas of E.Africa and the rift valley region experience hot temperatures which encourage high evaporation rates leading to high humidity

- Water bodies such as lakes and the Indian ocean act as sources of water vapour through evaporation. Areas near water bodies therefore experience high amounts of water vapour and hence high humidity e.g around the lake Victoria basin and the coastal areas compared to areas far away from water bodies e.g North eastern Uganda (Karamoja region) and North western Kenya (Turkana land)

- Vegetation cover

  Areas with thick vegetation cover such as forests experience high rates of evapotranspiration leading to high humidity than areas with scattered vegetation such as scrub, thickets and steppe savannah which experience minimum evapotranspiration and therefore low humidity

- Inter Tropical Convergence Zone (I.T.C.Z)

  The apparent movement of the sun leads to variations in humidity between the northern and southern hemisphere. When the sun is overhead in the north, hot temperatures are experienced leading to high humidity in the north and low humidity over the south while the south experiences high humidity than the north when the sun is overhead in the south. The equatorial region however experiences uniformly hot temperatures throughout the year thereby leading to high humidity

- Continentality or Distance from the sea

  Areas near the coast experience high humidity because of the effect of the land and sea breezes while the areas far away from the coast experience low humidity due to the absence of land and sea breezes. Coastal areas also experience low humidity due to the effect of warm ocean currents which transfer warm temperatures towards the land masses leading to high evaporation

- Influence of ocean currents

Warm ocean currents raise the temperature of the winds blowing over them hence resulting into high humidity while cold ocean currents have a cooling effect on the winds blowing over them leading to low humidity. The high humidity experienced along the E.African coast is therefore as a result of the

influence of the warm Mozambique currents

- Prevailing winds

  Moist winds such as the South east trade winds cause high humidity in the areas over which they blow e.g the E.African coastal areas and the Lake Victoria basin. However, dry winds with less moisture cause low humidity in the areas over which they blow e.g the North east trade winds are responsible for the low humidity in Karamoja in North eastern Uganda and in the Turkana land in North western Kenya

- Relief

  Highland areas tend to have high humidity on the wind ward side because of the ascending moist winds e.g on the wind ward side of Mt Rwenzori, there's high humidity than on the lee ward side

- Human activities such afforestation, re afforestation and agro forestry encourage high rates of evapotranspiration resulting into high amounts of water vapour in the atmosphere hence high humidity while activities like bush burning, overgrazing, deforestation and swamp reclamation lead to reduced evapotranspiration and hence low humidity

Qn a) Distinguish between absolute humidity and relative humidity

b) Account for the variations in the humidity experienced in E.Africa

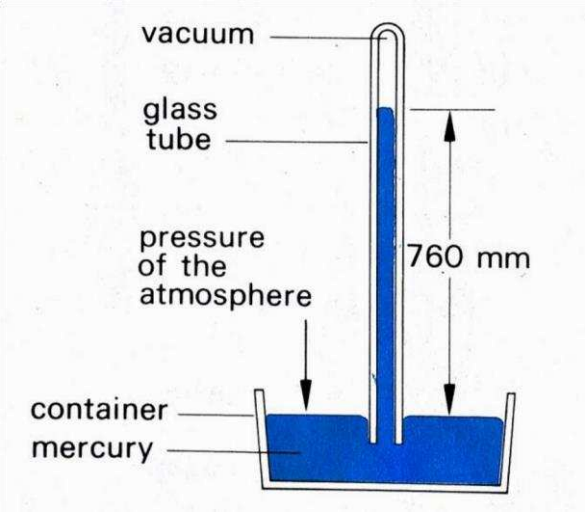
AIR PRESSURE

It is the weight (force) of the air exerted per unit area on the earth's surface. It is mathematically expressed as:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

The weight of air is the vertical column exerted from the upper limit of the atmosphere to the earth's surface which is approximately $1.034 kg/cm^3$ over the sea level. It is measured and recorded in units known as **Millibars**. However, the average pressure or weight of the air on the earth's surface is measured in **Millibars per unit area**.

Atmospheric pressure is measured using a mercury barometer or an aneroid barometer. A **mercury barometer** consists of a glass tube which is inverted over a bowl of mercury. The glass tube is marked in mm as illustrated below:



Air has weight and therefore exerts pressure on the earth's surface. A rise in atmospheric pressure caused by air pressure over the surface forces the mercury to rise in a glass tube.

When atmospheric pressure falls, mercury is forced to flow out of the glass tube and the mercury column in the glass tube falls

Atmospheric pressure is measured by looking at the column of mercury supported in the glass tube

It is expressed in Millibars e.g 750mm of mercury corresponds to 1000millibars (mbs) **N.B**: When air pressure changes, the weight of the mercury column changes accordingly i.e when air pressure increases, the mercury column in the glass tube rises and vice versa. The recorded mean pressure values are used in tables, maps and charts.

An **aneroid barometer** comprises of a small metal container with most of the air driven out to form a vaccum.

Since there's practically no pressure at all inside the box, any increase in pressure on the outside of the box will cause the lid to move inwards hence registering high pressure by the indicator on the revolving dial.

When there's a decrease in pressure, the lid springs outwards registering or recording (indicating) low pressure by the indicator on the revolving dial.

Pressure varies from one place to another and from time to time.

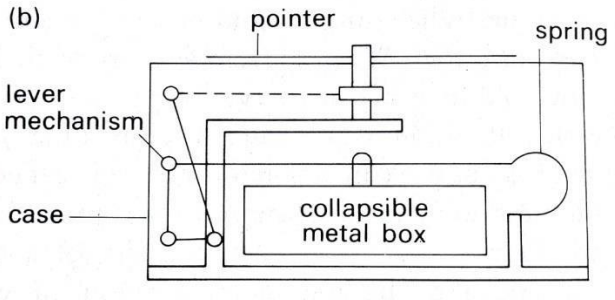


Fig. 13.11 (b) section through aneroid barometer

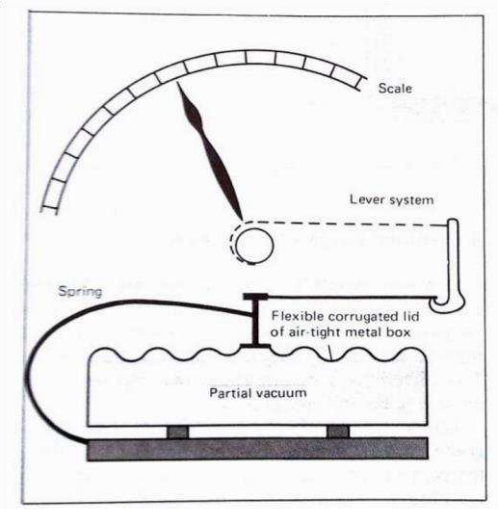


Fig. 11.3 *Aneroid barometer which measures air pressure*

Factors influencing atmospheric pressure:

- Temperature

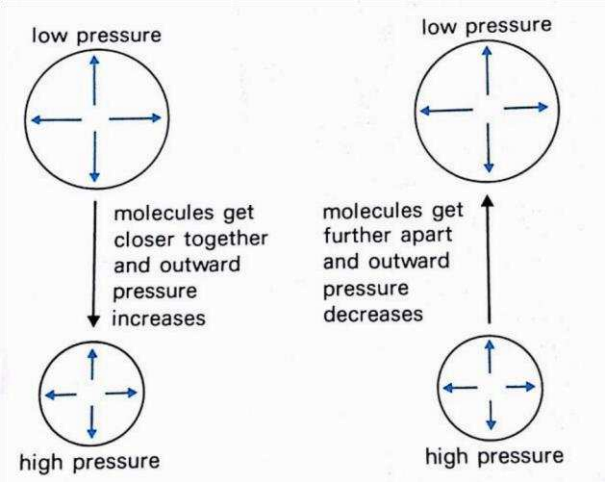
  There's an inverse relationship between the temperature and atmospheric pressure of a place.

  Hot temperatures lead to low pressure while cold temperatures lead to high atmospheric pressure. When air is heated, the air molecules expand and spread over a wide area resulting into low pressure while low or cold temperatures result into contraction and condensation of air molecules thereby exerting high pressure on the earth's surface. For that matter, Polar regions are high pressure zones while equatorial areas are low pressure belts.

- Altitude

  Atmospheric pressure decreases with an increase in altitude. This is because air at a high altitude spreads over a wide area which reduces its weight thereby causing low pressure. So, high altitude areas like highlands / mountain tops have low pressure due to the gravitational force towards the low altitudes.

  Low altitude areas such as foot hills and sea level on the other hand experience high pressure because the air near the ground supports the weight of air above it hence, the underlying or bottom air molecules constantly push downwards onto the earth's surface. This is also due to the high concentration of air impurities like dust particles and carbondioxide at the low altitudes.



- Rotation of the earth

As the earth rotates, air at the poles (North and South poles) is blown away towards the equator. It crosses parallels which are getting longer. The cold dense air at the poles crosses from the high latitudes towards the equator spreading over a wide area leading to low pressure. This accounts for the low pressure at the equator.

Air rising at the equator spreads out as it moves towards the poles. It crosses parallels which are getting shorter and contracts to occupy a small space. Its pressure therefore rises. This accounts for the high pressure at the horse latitudes.

- Latitudinal location

Air pressure tends to increase away from the equator towards the Polar Regions. The equatorial region experiences low air pressure because of the intense or high insolation (heat) from the overhead sun while Polar Regions which experience a low intensity of insolation experience high pressure

- Nature of the earth's surface

Land and water surfaces experience varying air pressure because of differences in the rate of heating and heat loss. This however affects atmospheric pressure at a local scale. During the day, land surfaces absorb heat faster than water surfaces leading to low pressure over the land and high pressure over the sea. Conversely at night, low pressure develops over the sea and high pressure over the land

because the land surface cools faster than the water surface

- Amount of water vapour in the atmosphere

Moist air is cold and dense hence it exerts high pressure on the earth's surface while dry air with little or no moisture is warm and light (less dense) hence exerting low pressure on the earth's surface

- Apparent movement of the sun (Influence of the I.T.C.Z)

Low pressure belts shift with the apparent movement of the overhead sun. When the sun is overhead the northern hemisphere (Tropic of Cancer) in June – July, high temperatures are experienced in the north leading to low pressure and high pressure over the southern hemisphere. In December – January when the sun is overhead in the southern hemisphere (Tropic of Capricorn), temperatures rise and low pressure develops over the south while the north develops high pressure.

Qn a) Describe how atmospheric pressure is measured and recorded at a weather station

b) Explain the factors that influence the atmospheric pressure of a place

PRECIPITATION It refers to all forms of moisture which fall on the earth's surface from the atmosphere. Precipitation occurs as a result of the condensation of water vapour in the atmosphere to form rainfall, hail, fog and dew.

Precipitation forms under the following conditions:

- Adiabatic cooling of air which occurs when moist air rises and cools until when the temperatures reach the dew point at the condensation level. The water vapour condenses to form clouds or precipitation
- Air contact with a cold surface

When warm moist air moves over a cold surface, the water vapour is cooled and it condenses into precipitation. This commonly occurs over the sea leading to the formation of fog

- Mixing of air in the atmosphere

When two (2) air masses or wind systems meet in the atmosphere, the warm air is cooled down and it condenses leading to the formation of water droplets Terrestrial radiation at night

Rapid loss of heat by the land surface causes rapid cooling which also in turn causes the condensation of water vapour near the earth's surface. This is responsible for the formation of dew especially in the semi arid areas

- The degree of relative humidity

When air is fully saturated i.e with a relative humidity of 100%, any increase in water vapour results into condensation to take place hence forming water droplets

- Existance of condensation nuclei

The amount of tiny particles in the atmosphere such as dust and smoke facilitate the occurrence of condensation. Water molecules often form or cling onto these tiny particles suspended in the atmosphere acting as condensation nuclei

N.B: Condensation in the atmosphere results into the formation of clouds. Clouds are defined as thick water droplets suspended in the atmosphere as a result of the condensation of water vapour when temperatures drop to the dew point. Clouds in the atmosphere affect the weather conditions of a given place in the following ways:

- Clouds lead to low surface temperatures by absorbing radiation from the sun during the day. This reduces the amount of insolation received on the earth's surface
- Clouds regulate warm temperatures during the night by acting as a blanket that prevents heat loss from the earth's surface. Areas with thick cloud cover e.g the equatorial region experience a low diurnal range of temperature due to the reduced amount of heat loss at night
- Dense cloud cover results into dark un clear conditions during day time. Thin cloud cover results into clear sunny day conditions
- Thick cloud cover is associated with heavy rainfall while thin clouds lead to little or no rainfall at all

- Low altitude clouds like mist and fog reduce visibility that hinders human activities such as transport thereby causing accidents.

RAINFALL

It is defined as coalesced water droplets that fall under the influence of gravity. It occurs as a result of condensation of water vapour in the atmosphere. The water droplets become heavy to be held up in the atmosphere and hence, they later on fall down to the ground under the influence of gravity.

Types of Rainfall:

- **Convectional Rainfall**

It is a type of rainfall which occurs as a result of evaporation induced by heat. Evaporation releases water vapour into the atmosphere which condenses to form clouds and later rainfall. It is common in the equatorial areas which experience intense heating almost throughout the year while in the mid latitudes, it is received during summer. The heat from the sun causes evaporation from the land and water surfaces as well as evapotranspiration from vegetation. The water vapour rises until when it reaches the condensation level where it cools and condenses into water droplets or clouds which result into rainfall.

Characteristics of Convectional rainfall:

- It is experienced in areas with intense heating
- It is associated with prolonged rains covering a wide area
- It is mainly received in the afternoons
- Lightning and thunderstorms are so common
- It involves heavy showers
- It occurs during summer in the mid latitudes

- **Orographic Rainfall**

It is also known as relief rainfall.

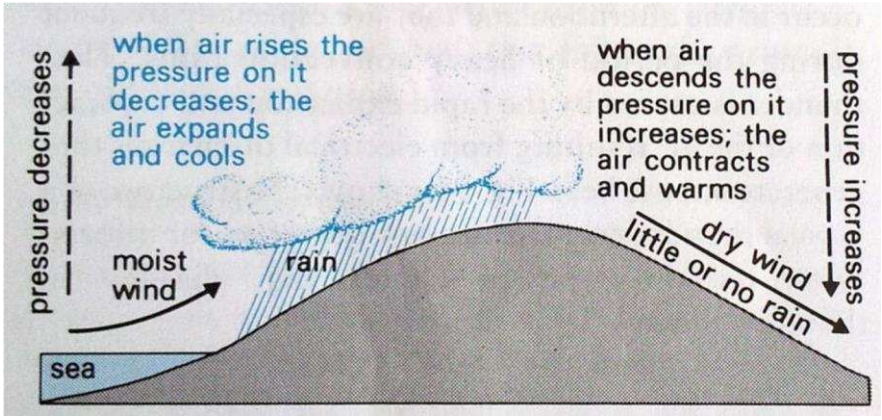
This is a type of rainfall experienced in the highland areas. It occurs when moist air is forced to rise upwards by a relief barrier such as a mountain (highland) or hill. The onshore moist air rises until when it reaches the condensation level to form clouds which consequently release rainfall on the wind ward side. Air rises up the mountain cooling at an adiabatic lapse at the condensation point at an average rate of 1^{o}c per 100metres to form cumulo nimbus clouds. As the clouds become dense, water droplets are released as rainfall on the wind ward slopes. Air descends on the lee ward side when it is cool and dry hence resulting into little or no rainfall. This region is called the rain shadow.

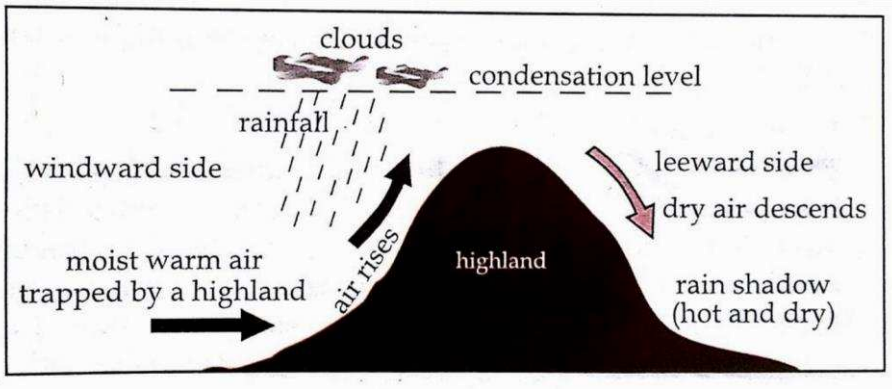
This type of rainfall is common in the mountainous areas / highlands of Kilimanjaro, Rwenzori, Elgon, Muhavura and Mt Kenya

Characteristics of Relief rainfall:

- It is often heavy on the wind ward side of the highlands

- It occurs as a result of the ascent of moisture laden air over a highland
- It involves prolonged periods of rain or precipitation
- It occurs in proximity to highlands Occasional thunderstorms and hail are common





- **Frontal (Cyclonic) Rainfall**

It is a type of rainfall which occurs when two air masses of different characteristics meet at a front. The warm air mass is forced to rise over the cold dense air mass which descends at front. Warm moist air rises and cools at an adiabatic lapse rate until when the condensation level is reached. Condensation occurs to form clouds which eventually release water droplets called frontal rainfall.

Characteristics of Frontal Rainfall

- It is experienced along fronts such as the Inter tropical convergence zone (I.T.C.Z) where trade winds meet
- It involves heavy showers covering small local areas
- It lasts for only a few hours It involves violent thunderstorms

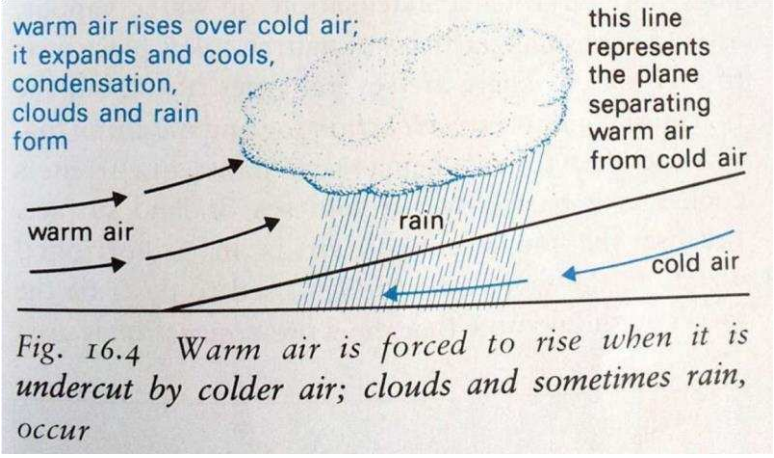
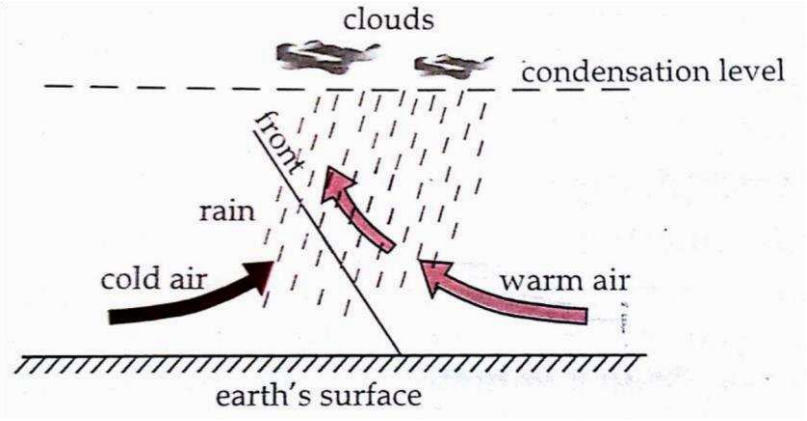


Fig. 16.4 Warm air is forced to rise when it is undercut by colder air; clouds and sometimes rain, occur



FACTORS INFLUENCING RAINFALL DISTRIBUTION IN E.AFRICA:

Rainfall distribution refers to the pattern in which rainfall is spread over a given area in a specific period of time.

Rainfall in E.Africa varies mainly in terms of amount and seasonality. Heavy rainfall of over 1000mm per annum is experienced in areas around the Lake Victoria basin, coastal areas and the highland areas of Mt Kenya, Elgon and around the Kigezi highlands among others.

Moderate rainfall ranging between 760-1000mm per annum is experienced in South western Tanzania, Central and Northern Uganda]as well as Southern Kenya

Low rainfall of less than 760mm per annum is received in areas like Karamoja region, Ankole Masaka corridor, Turkana land, Masai land and the Albert flats

The variations in the amount of rainfall received in E.Africa are influenced by the following factors:

- Apparent movement of the sun (I.T.C.Z)

In June – July when the sun is overhead in the north, intense heating occurs creating a low pressure belt and the convergence of moist winds which result into heavy rainfall in the north. The same condition is experienced in the south in December – January. The north and south therefore experience a single

rainfall maximum due to the movement of the sun. Because the sun is overhead at the equator twice in a year, a double rainfall maxima is experienced in the equatorial areas such around the Lake Victoria basin

- Prevailing winds

They have a rainfall effect on the areas over which they blow because they transfer weather characteristics to the areas where they move. The South east trade winds emerge from the Indian ocean when they are moist so they are responsible for the heavy rainfall experienced along the E.African coast as well as the northern shores of lake Victoria while the North east trade winds from the Arabian desert are responsible for the low and un reliable rainfall in North eastern Uganda and North western Kenya

- Vegetation cover

Areas with thick vegetation cover like tropical rain forests experience heavy rainfall due to the high rates of evapotranspiration e.g around Mabira, Budongo and the coastal areas with mangrove forests. On the other hand, semi arid areas with scattered vegetation cover experience low and un reliable rainfall e.g Karamoja region and Turkana land

- Influence of water bodies such lakes and the Indian ocean recharge the atmosphere with water vapour through evaporation as well as through land and sea breezes. Therefore, areas near water bodies experience heavy convectional rainfall e.g the lake Victoria basin and the coastal areas while areas far away from water bodies experience low and un reliable rainfall e.g In North eastern Uganda

- Relief

Highland areas in E.Africa experience heavy rainfall on the wind ward slopes since they act as barriers towards the movement of the moist winds hence forcing them to rise upwards towards the condensation level thereby forming orographic rainfall. On the other hand, lowland areas like the Albert flats experience low rainfall due to the absence of relief barriers to trap them

- Altitude

High altitude areas like mountainous regions experience heavy rainfall due to cool temperatures which induce condensation of moisture bearing winds while areas of low altitude experience low to moderate rainfall due to the limited cooling effect for instance Mt Elgon areas receive heavy rainfall than the rift valley region

- Latitudinal location

Areas located at or near the equator experience heavy rainfall which is evenly distributed throughout the year with a double rainfall maxima in March and September because the sun is overhead at the equator twice in a year while areas far away from the equator experience moderate to low rainfall with a single rainfall maximum because the sun is overhead at the tropic of cancer in the north and tropic of Capricorn in the south once in a year

- Ocean currents

Warm ocean currents like the warm Mozambique currents increase the temperature of the ocean water and cause an increase in the rate of evaporation. The water vapour is therefore picked up by the onshore winds resulting into heavy rainfall in the coastal areas of E.Africa between Mombasa and Dar es Salaam

- Corriolis force effect

According to Ferrel's law, the South east trade winds are deflected to the right of their path as they cross the equator due to the rotation of the earth. This is responsible for the heavy rainfall received around

the northern and north eastern shores of lake Victoria while low and un reliable rainfall experienced in the Ankole Masaka corridor

- Perturbation

It refers to the development of low pressure belts over the Indian ocean due to intense insolation. This forces winds from the interior of E.Africa to blow offshore (seaward) resulting into heavy rainfall over the Indian ocean and dry conditions in North eastern Kenya

- Coastal configuration

The North east and South west alignment of the coast forces winds to blow parallel to the coast instead of blowing onshore. This is responsible for the low rainfall received in North eastern Kenya

- Human activities such as deforestation, overgrazing, sinking of bore holes and swamp reclamation among others reduce the rate of evaporation and evapotranspiration

resulting into low rainfall e.g in the Karamoja region and Turkana land. On the other hand, afforestation and re-afforestation result into increase in the rate of evaporation and evapotranspiration hence increasing the amount of rainfall in the areas where the trees are planted

Qn a) Distinguish between convectional rainfall and orographic rainfall b) Account for the variations in rainfall distribution in E.Africa

FOG

It refers to tiny and light water droplets which form close to the earth's surface. It is a meteorological condition where condensation occurs at a low altitude or near the ground surface resulting into poor visibility over a given area to about 1 kilometre (0.62 miles).

Fog develops by condensation of water vapour in the atmosphere near a cold surface. For condensation to occur, condensation nuclei such as smoke and dust particles must be suspended in the atmosphere near the earth's surface. **Types of Fog:**

There are different types of fog which occur depending on the conditions of formation

- **Radiation fog**

It is a type of fog which is formed due to rapid terrestrial radiation and cooling of the earth's surface. It mainly occurs at night. The air near the earth's surface therefore cools and condenses to form a layer of fog called radiation fog

- **Advection fog**

It is a type of fog formed when warm moist air passes over a cold surface. This causes rapid cooling and condensation of the lower layers of air to form fog

- **Frontal Fog**

It is a type of fog formed when a warm air mass meets with a cold air mass. The cold air mass cools down the warm air mass above it resulting into condensation near the earth's surface. This is so common around the coastal areas and the Inter tropical convergence zone

- **Hill fog**

It refers to a low sheet of cloud that covers the lower slopes of hills. It is common in the hilly and mountainous areas which experience cool / low temperatures at high altitude. The rising air is cooled down along the hill slopes leading to pre mature condensation that results into the formation of hill fog

- **Steam fog**

Is a type of fog formed when a cold air mass passes over a warm water surface. The water vapour from the water surface condenses easily upon mixing with the overlying cold air. Steam fog forms rapidly and disappears quickly.

HAIL

It refers to frozen rain droplets which usually range between 5 – 50 mm in diameter. The frozen rain droplets usually have a concentric layer of ice as well as being white and opaque in character.

Hail is a form of precipitation which falls on the earth's surface in form of small ice pellets or hail stones.

It is associated with extreme instability in the atmosphere resulting from uplift of air by convective currents

Hail forms due to the condensation of moisture in the lower atmosphere followed by strong rising air currents. The water droplets are therefore pushed up to the freezing point to form ice pellets which are thick and dense enough to overcome the uprising air currents. Consequently, ice falls on the earth's surface in form of hail stones.

It usually occurs in unstable cumulo nimbus clouds where vertical uplift or rise of air is strong enough to carry condensed droplets above to great heights of the freezing level where they are turned into ice crystals at a very high altitude.

The initial droplets freeze above the freezing point hence condensation nuclei is ice. After being carried upwards to greater heights by the uprising air currents, an additional layer of ice is formed on the original ice nucleus by collision and coalescence with super cooled water vapour / droplets around.

The pellets fall and rise many times until when the weight of the enlarged ice crystals is sufficiently great to overcome any uprising current. Finally, the crystals fall as hailstone due to gravity

Qn. Describe the processes leading to the formation of the following: a) Fog

b) Hail

c) Orographic rainfall

WIND

It is defined as moving air or air in motion. Air usually moves in a definite direction and is therefore referred to as a wind system.

Winds often blow from regions of high pressure to regions of low pressure determined by temperature differences.

Winds are either local or global. Global winds are generally referred to as Air masses and they have great influence on the climate of extensive areas while local winds have micro climatic influence.

Winds may also be referred to as breezes when they are light.

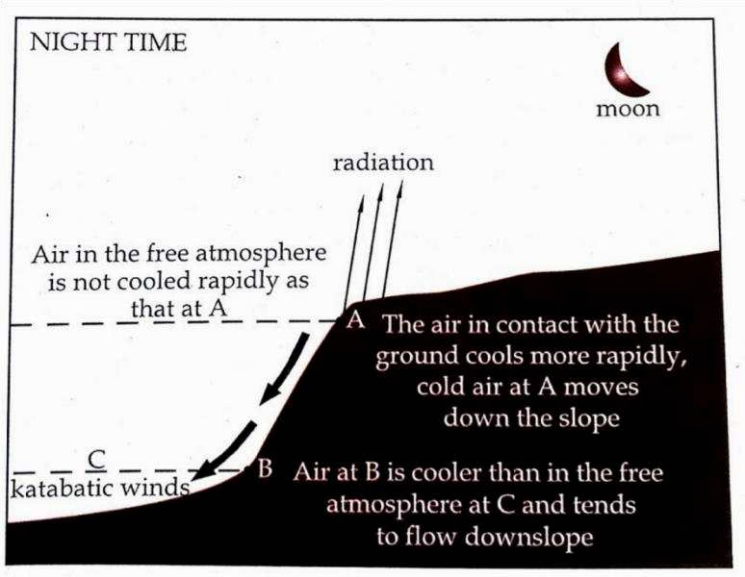
LOCAL WINDS

They are winds which blow over localized areas i.e they are less extensive wind systems. They result from differences in pressure in particular areas leading to air masses from areas of high pressure to blow towards areas of low pressure.

TYPES OF LOCAL WINDS:

A. KATABATIC WINDS

They are local winds which move down slope under the influence of gravity at night. They occur in highland areas at night when cold dense air moves down slope. Katabatic winds form due to rapid cooling of the highland slopes at night due to their exposure leading to high pressure over the slopes. The slopes lose a lot of heat through radiation hence they cool down much faster than the valleys ultimately becoming areas of high pressure. The air on the slopes becomes denser than the air in the valleys. The cold dense air from the highland slopes therefore blows down slope (descends) to the valleys i.e from a high pressure zone to a low pressure zone forming a Katabatic wind as illustrated below;



Katabatic winds normally result into the following weather conditions:

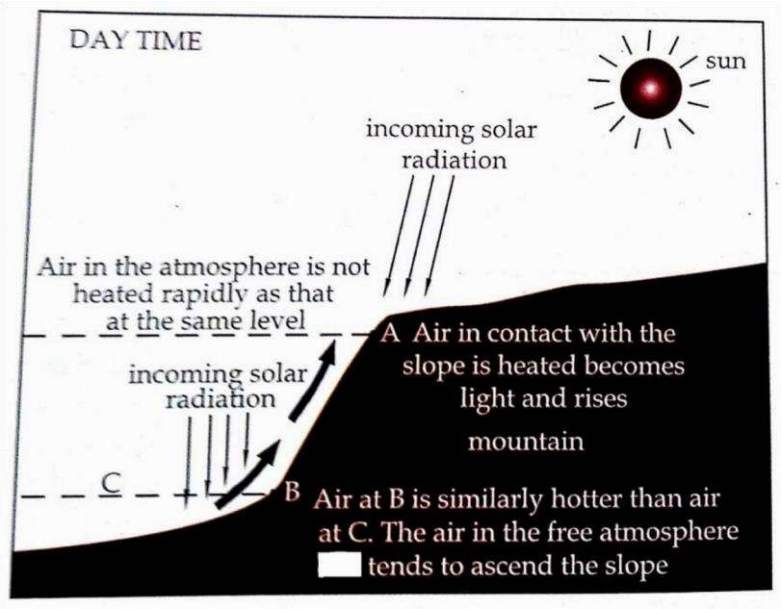
- There's formation of mist and fog in the valleys especially in the morning hours because of the meeting of descending cold air and the warm air in the valley
- Cold conditions are created in the valleys during the night usually extending to the morning hours
- Temperature inversion is experienced in the valleys as the cold descending air displaces the warm air upwards thus the air in the valley is colder than the air above it
- Frost conditions are experienced in the valleys due to rapid cooling caused by the descending cold air

B. ANABATIC WINDS

They are local winds which flow from the valleys upwards the highland slopes during the day. They occur as a result of the differences in the rate of heating between the valley and the upper slopes in highland areas.

During the day, the highland slopes are heated more than the valleys hence, the air over the hill slopes is heated, it expands, becomes light and rises upwards thereby creating a low pressure zone hence convectional rising of air on the upper slopes. The cold dense air in the valleys under high pressure rises

up the slopes to replace the vacuum created by the warm rising air finally resulting into Anabatic winds as illustrated below:



Anabatic winds result into the following weather conditions:

- Formation of mist and fog on the upper slopes of the mountains as the ascending cold air moves over a warm surface
- Orographic rainfall is experienced in the mountainous areas as warm air rises from the upper slopes
- Low clouds are formed in highland areas due to the cooling effect of the ascending cold air at and beyond its condensation level or dew point
- Cold temperatures are transferred from the valleys to the upper slopes of the highlands

Qn a) Distinguish between Anabatic winds and Katabatic winds

b) Describe the weather conditions associated with:

I. Anabatic winds

II. Katabatic winds

C. LAND BREEZE

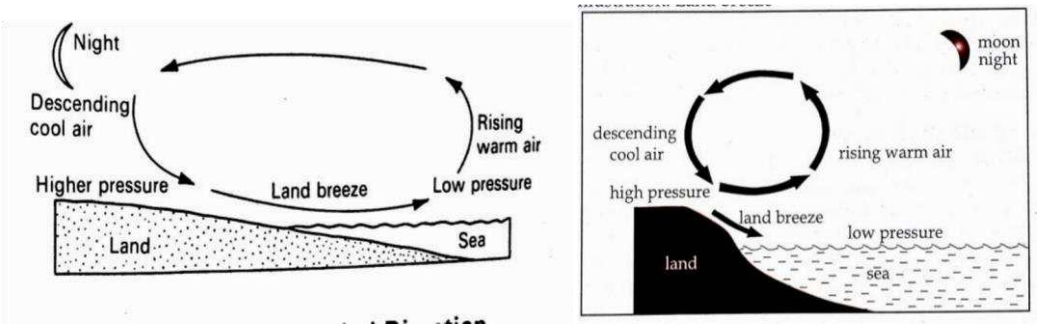
In general, land and sea breezes are local winds which occur in areas where land lies in close proximity to a water body such as around the L.Victoria shores and the coastal areas of E.Africa.

Factors for the occurrence of Land and Sea breezes:

- Differences in specific heat capacities of the land and sea
- Mobility of water compared to the solid land
- Heat transmission through the transparent water as opposed to the opaque land

- Differences in the reflecting capacity of the land and water

A land breeze is the movement of cold dense air from the land towards the sea. It occurs at night. It is as a result of differences in the air pressure between the land and water surface. Rapid terrestrial radiation over the land leads to rapid cooling hence creating a high pressure belt while low pressure is created over the warm sea surface. Wind therefore blows from the land towards the sea as a Land breeze.



Causes of a Land breeze:

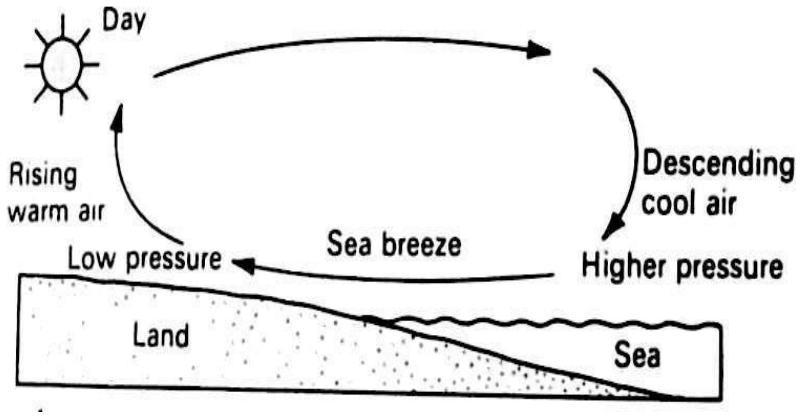
- Loss of radiation at the coastal lands at night. Land therefore cools faster than the sea / water hence temperatures are cooler over the land than the sea which retains much of its heat
- Water loses heat more slowly such that the air above it remains relatively warm
- Low pressure is created over the warm sea and high pressure over the cold land. Cool air from the land under high pressure blows towards the sea to replace the rising air hence forming a land breeze

Effects of a Land breeze:

- It results into lowering of temperature over the sea as cold air from the land blows towards the sea
- Formation of fog / misty conditions occurs over the sea as cold air from the land cools down the warm air over the sea leading to premature condensation as well as poor visibility
- Temperature inversion occurs over the sea as cold air from the land displaces warm air upwards over the sea
- Dense clouds and heavy offshore rainfall are experienced over the sea as warm air is displaced upwards to the condensation level
- It results into dry conditions on the land because little or no rainfall is received
- It results into violent thunderstorms
- It also causes high humidity over the sea / lake

D. SEA BREEZE

It is the movement of cool moist air from the sea towards the land. It occurs during the day. Rapid heating of the land surface during the day creates a low pressure belt over the land while high pressure develops over the sea which is less heated. So land warms faster than the sea hence temperatures are high over the land and cold over the sea. Convective currents of warm air rise over the land and create low pressure at the sea surface. This forces cool moist wind (air) to blow from the sea towards the land to replace the rising air hence forming a sea breeze as illustrated below;



Effects of a Sea breeze:

- It lowers temperature on the land especially in the afternoons as cool air from the sea replaces the rising warm air
- It is associated with onshore convectional rainfall which is normally received in the early morning and afternoon hours
- It causes violent thunderstorms
- It results into high humidity over the land
- Thick cloud cover is formed over the land
- It leads to the formation of fog / misty conditions on the land which results into poor visibility

Qn. Examine the causes and effects of land and sea breezes in East Africa

F. FOEHN WIND

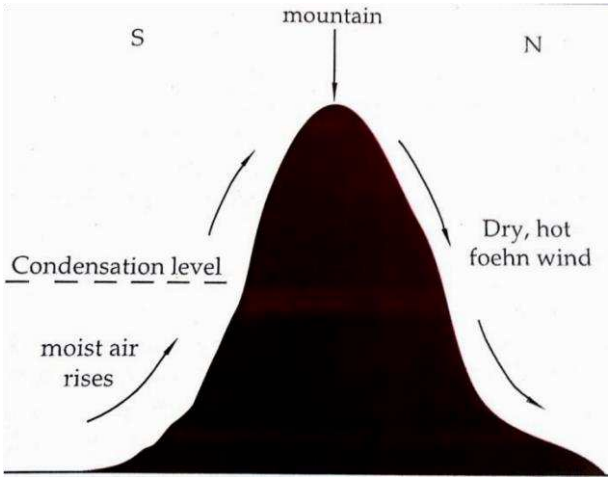
It is a dry wind experienced on the lee ward side of mountains when descending air becomes compressed with increased pressure.

It is experienced in the valleys of the northern Alps particularly in Switzerland during spring

Air is forced to move upwards the southern slopes of the Alps, where it later expands and cools. Condensation takes place when the air is saturated. Rain and even snow falls on the higher slopes.

On the lee ward slopes, the air descends and gains heat due to an increase in temperature. The air is compressed and warmed. Most of its moisture is lost and wind reaches the valley bottom as a dry hot wind known as a Foehn wind

The wind incidentally causes a sudden rise in temperature. Being hot and dry, sometimes it triggers off wild fires in the Alpine valley as well as causing low relative humidity



G. CHINOOK WIND

The term "Chinook wind" is derived from the Indian word "Chinook" which means "Snow eater."

It is called so because it is hot and it causes melting of snow. Chinook winds are experienced on the eastern slopes of the Rocky mountains in the United States of America and Canada during the winter season.

Chinook winds are similar to Foehn winds in terms of development and effects. They only differ in areas of occurrence (operation)

Chinook winds are so hot that they can raise the temperature of an area by 19^{o}c within 25minutes.

Chemistry

RATES OF REACTION

[CHEMCIAL KINETICS]

Rates of reaction deals with how fast a chemical reaction goes to completion.
It is the amount of products formed per unit time or the amount of reactants used up per unit time.
Some reactions are immediate e.g. the suspension reactions (precipitation reaction) other reactions take days such as rusting of iron while others take months or years e.g. fermentation of grapes to form wine.
The rate at which a chemical reaction proceeds is determined by several factors. One such factor is concentration of the reactants. The rate of the reaction is directly proportional to the concentration of the reactants i.e. as the concentration of the reactants increases, the rate of the reaction increases.
Consider the general equation

$$A + B \rightarrow C$$

Rate of reaction α concentration of a and concentration B

$$\text{Rate} = K[A]^x [B]^y$$

The expression showing the relation between the rate of the reaction and the concentration of the reactants is called the rate expression or rate equation.
The power to which the concentration of the reactants is raised in the rate equation is called the order of the reaction with respect to that reactant i.e. x is the order of the reaction with respect to A and Y is the order of the reaction with respect to B. the sum of the powers to which the concentration of the reactants are raised in a rate equation is called the overall order of the reaction. i.e. in the above reaction, the overall order of the reaction is x+y.
K is called the rate constant. It is a constant for proportionality in the rate equation.
NB:
Orders of reactions are experimentally determined. They are not related to the stoichiometry of the reaction.

Characteristics of some orders of reactions

(a) Zero order reaction
Consider the equation

$$A \rightarrow B + C$$

$$\text{Rate} = K[A]^x$$

For zero order reaction, x = 0.

$$\text{i.e Rate} = K[A]^0$$

$$\text{but Rate} = \frac{-d[A]}{dt} = \frac{d[c]}{dt}$$

$$\frac{-d[A]}{dt} = K$$

let [A] be a

$$\frac{-da}{dt} = K$$

$\int -da = \int Kdt$

$-a = Kt + C$

When $t = 0$, $C = -a_0$

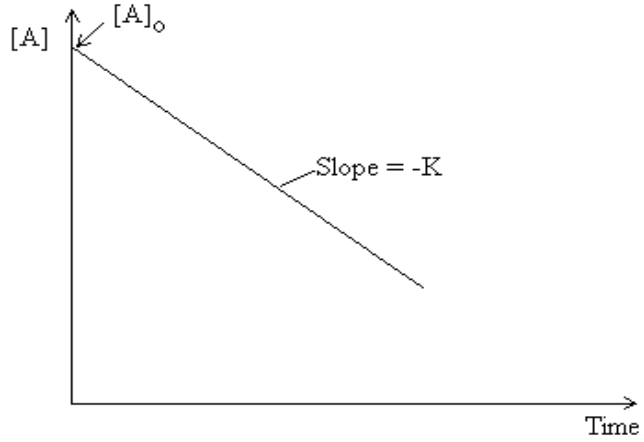
$-a = KT - A_0$

$A = -Kt + a_0$

$\therefore [A] = -Kt + [A]$

Compare with $y = mx + C^0$

The above equation shows an equation of a straight line with a negative gradient. i.e. for a zero order reaction when the concentration of the reactant is plotted against time a straight line with a negative gradient is obtained.



At half life, $t_{½}$

$[A] = \frac{[A]}{2}$

$\frac{[A]_0}{2} = Kt_{½} + [A]_0$

$\frac{[A]_0}{2} - [A]_0 = -Kt_{½}$

$\frac{-[A]}{2} = -Kt_{½}$

$\frac{[A]_0}{2} = Kt_{½}$

$\therefore [A]_0 \alpha\ t_{½}$

For zero order reaction, the half life decreases as the concentration of the reactants decreases.

(1) Hence, for a zero order reaction a plot of the concentration of the reactant against time is a straight line with negative gradient.
(2) The half life of the reaction decreases as the concentration of the reactant decreases.

1st ORDER REACTION

Consider the equation

$A + B \rightarrow C$

Rate $= K[A]^x [B]^y$

The reaction is first order when

$X = 0$ and $y = 1$ or when $x = 1$ and $y = 0$

Taking x = 1 and y = 0

$$\text{Rate} = \frac{-d[A]}{dt} = K[A]$$

$$\therefore \frac{d[A]}{dt} = -K[A]$$

Taking concentration of [A] as x

$$\frac{dx}{dt} = -Kx$$

$$\int \frac{1}{x} dx = \int K dt$$

$$\ln x = -Kt + C$$

If $t = 0$, $x = x_0$

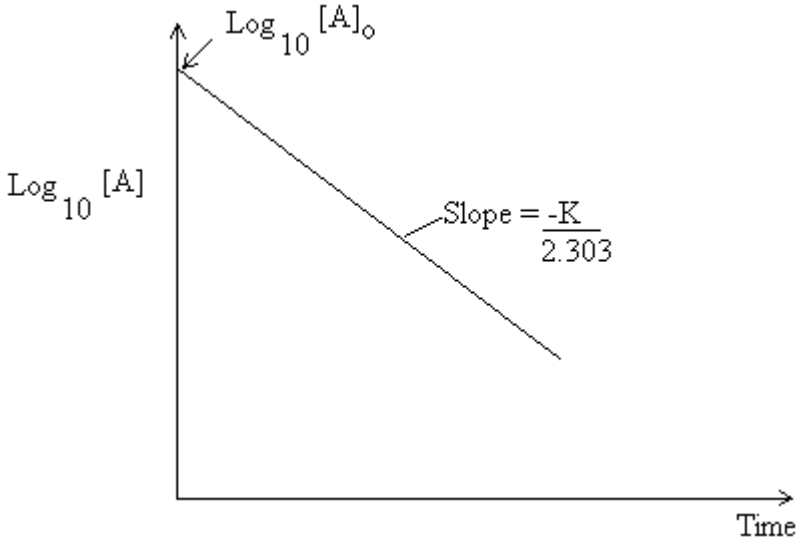
$\therefore \ln x_0 = C$

Substituting for C

$$\ln x = -Kt + \ln x_0$$

$$\ln[A] = -Kt + \ln[A]_0$$

For a first order reaction a plot of the logarithm of the concentration against time is a straight line with a negative gradient.



At $t_{½}$, half life

$$[A] = \frac{[A]_0}{2}$$

$$\ln \frac{[A]_0}{2} = -Kt_{½} + \ln[A]_0$$

$$\ln \frac{[A]_0}{2} - \ln[A]_0 = -Kt_{1/2}$$

$$\frac{\ln \frac{[A]_0}{2}}{[A]_0} = -Kt_{1/2}$$

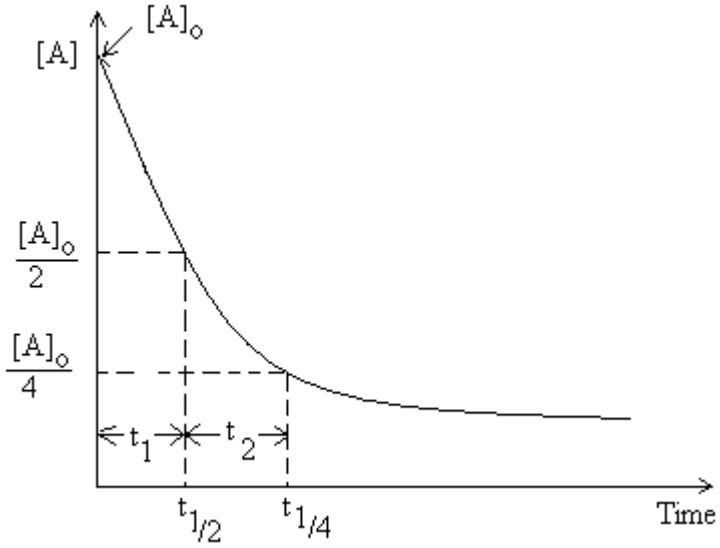
$$\ln \tfrac{1}{2} = -Kt_{1/2}$$

$$-0.693 = -Kt_{1/2}$$

$$t_{1/2} = \frac{0.693}{K} = \text{Constant}$$

For the first order reactions, half life does not depend on the concentration of the reactants.

NB: For a first order reaction, a plot of [A] vs time gives a graph on which $t_1 = t_2$



SECOND ORDER RACTION

Consider a reaction

$A \rightarrow B + C$

$$\text{Rate} = K[A]^x$$

$$\text{i.e.} \quad \frac{d[A]}{dt} = -K[A]^2$$

Let $[A] = X$

$$\text{Then} \quad \frac{dx}{dt} = Kx^2$$

$$\int 1/x^2 dx = \int -k dt$$

$^{-1}/_{X}$ = -kt + c

i.e $^{1}/_{[A]}$ = kt + c

when t = 0, $[A] = [A]_0$

$\therefore$ $^{1}/_{[A]0}$ = c

Substituting for c

$\frac{1}{[A]}$ = $kt + {}^{1}/[A]_0$

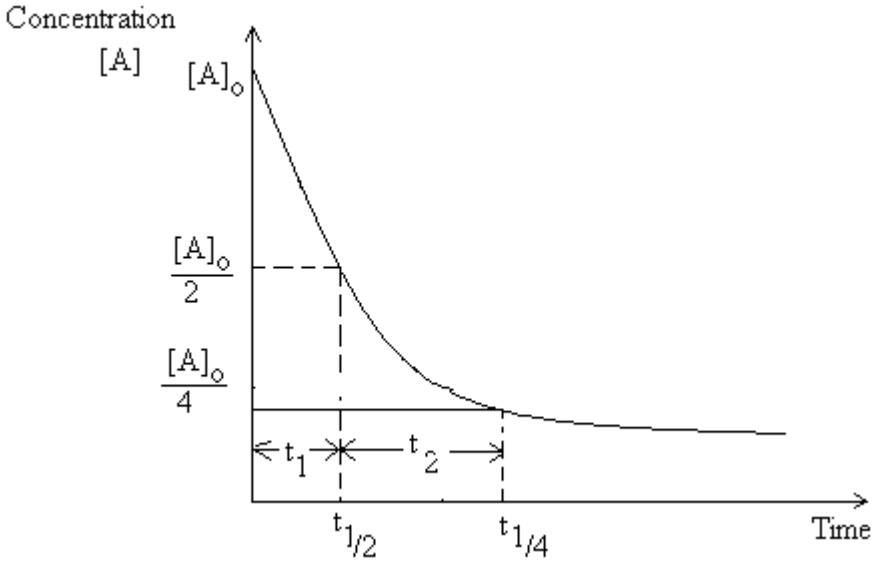
Therefore, a plot of the reciprocal of the concentration of the reactants against time is a straight with a positive gradient.

At half life, $t_{½}$, $[A] = \frac{[A]_0}{2}$

$\frac{2}{[A]_0} = kt_{½} + \frac{1}{[A]_0}$

$\frac{1}{[A]_0} = kt_{½}$

i.e. For second order reaction, half life is inversely proportional to the concentration of the reactants.



For second order reactions $t_2 = 2t_1$

NOTE: when [a] vs time is plotted.
For zero order - It's a straight line with a negative gradient.
First order - $t_1 = t_2$
Second order - $t_2 = 2t_1$

PSEUDO ORDER

Consider hydrolysis of ethyl ethanoate

$$CH_3COOC_2H_5(l) + H_2O(l) \overset{H^+}{\rightleftharpoons} CH_3COOH(l) + C_2H_5OH(l)$$

The reaction is first order with respect to the ester and first order with respect to water i.e. the rate of the reaction depends on the concentration of both the ester and water.
Rate = $K[ester][H_2O]$

However, when water is present in large excess the amount of water that reacts negligible. i.e. the concentration of water remains practically unchanged this implies that the rate of the reaction depends only on the concentration of the ester as a result, the order of the reaction is one. Such order of the reaction that is obtained as a result of one of the reactants being present in large excess is called a pseudo order.

Example 1
The data in table below were obtained for a reaction between a bromoalkane (RBr) and hot aqueous sodium hydroxide solution.

Time	0	9	18	27	40	54	72	105
Concentration of RBr	0.016	0.096	0.086	0.077	0.065	0.054	0.043	0.03

(a) State the order of the reaction with respect to
(i) Peroxide sulphate
(ii) Iodide ions
In each case give a reason for your answer.

(b) Find the value of the rate constant.
(C) Determine the initial rate of the reaction when the concentration of the peroxide sulphate ions is 0.12 and that of iodide ions is 0.02 mol per litre.

Solution
(a) (i) The order of the reaction is 1, this is because the concentration of $[S_2O_8^{2-}]$ is doubled and the initial rate is doubled.
Reason: Considering experiment 1 and 2, when the concentration of $[S_2O_8^{2-}]$ is doubled and that of Iodine ions is kept constant, the initial rate of the reaction also doubles.
(i) Order of reaction with respect to Iodide ions is 1. Since the concentration of the ions is halved and rate of the reaction is halved considering experiments 2 and 3.

Rate = $K[S_2O_8^{2-}][I^-]$

$9.6 \times 10^{-6} = K(0.04)(0.04)$

$$K = \frac{9.6 \times 10^{-6}}{(0.04)^2}$$

$= \quad 0.006\ s^{-1}$

(c) Rate $= \quad K[S_2O_8^{2-}][I^-]$

$= \quad 0.006 \times 0.12 \times 0.02$

$= \quad 1.44 \times 10^{-5}\ mol^2dm^{-6}S^{-1}$

Method 2

(a) Rate $= \quad K[S_2O_8^{2-}][I^-]$

Taking experiment 1.

$9.6 \times 10^{-6} = K(0.04)^x\ (0.04)^y$ …….. (1)

Taking experiment 2.
$1.92 \times 10^{-6} = K(0.08)^x\ (0.04)^y$ …… (2)

Equation (1) ÷ equation (2)

$$\frac{9.6 \times 10^{-6}}{1.92 \times 10^{-5}} = \frac{K(0.04)^x\ (0.04)^y}{K(0.08)^x\ (0.04)^y}$$

$$½ = \frac{(0.04)^x}{0.08}$$

$2^{-1} = 2^{-x}$

$x = 1$

∴ The order of reaction with respect to $[S_2O_8^{2-}][I^-]$ is 1.

(ii) Experiment 2.

$1.92 \times 10^{-5} = K(0.08)^x\ (0.04)^y$ …….(1)
Expt. 3
$9.6 \times 10^{-6} = K(0.08)^x\ (0.02)^y$ …… (2)

Equation (2) ÷ Equation (1)

$$\frac{9.6 \times 10^{-6}}{1.92 \times 10^{-5}} = \frac{K(0.08)^x\ (0.02)^y}{K(0.08)^x\ (0.04)^y}$$

$$½ = \frac{(0.02)^y}{0.04}$$

$y = 1$

Exercise 2

The following table shows data for the reaction $2A + B \rightarrow C + D$

Experiment	[A]moldm^{-3}	[B]moldm^{-3}	Initial rate per second
1	0.15	0.25	$1.4x10^{-5}$
2	0.15	0.50	5.6×10^{-5}
3	0.075	0.50	$2.8x10^{-5}$
4	0.075	0.25	$7.0x10^{-6}$

(a) Find the order of the reaction with respect to a and b and hence the overall order of reaction.
Order A – 1, Order – 2, overall = 1 + 2 = 3
(b) Calculate the value of the rate constant and give its units. $1.49 \times 10^{-3}moldm^{9}S^{-1}$
(c) Determine the initial rate of the reaction when the concentration of a 0.1 and that of b is 0.2 moldm^{-3}
5.96×10^{-5} rate per second.

Exercise 3.

The following kinetic data were obtained for the reaction between H_2O_2, iodide ions and hydrogen.

Concentration (moldm^{-3})			Rate (molS$_{-1}$)
H_2O_2	I^-	H^+	1.75×10^{-6}
0.01	0.01	0.10	5.25×10^{-6}
0.03	0.01	0.10	1.05×10^{-5}
0.03	0.02	0.10	1.05×10^{-5}
0.03	0.02	0.20	

(a) Determine the order of reaction.
(b) H_2O_2 . 1 (ii) Iodide ion^1 (iii) H^+ ions O.
Write the rate equation for the equation
Rate = $K[H_2O_2][I^-]$.

(c) Calculate the rate constant and give its units. $1.75 \times 10^{-2}dm^6\ mol^{-1}S^{-1}$

NB: Summary

Concentration	Rate	Order
2 times	3 times	Zero
2 times	2 times	First
2 times	2^2 times	Second order
3 times	3^2 times	Second order

Exercise
Compound A is converted to products B and C according to the equation.
$A \rightarrow B + C$
The data below was observed for the reaction.

Time/min	0.0	7.2	18.0	36.0	72.0	108.0
Concentration of A moldm^{-3}	100	91	79	63	40	25

Plot a suitable graph and using the graph determine;
(a) Half life of the reaction.

(b) The order of the reaction.
(c) The rate constant and state its units.

EXPERIMENTAL DETERMINATION OF ORDERS OR REACTION

The order of reaction can be obtained from a graph of the amount of reactants against time using half life method or it can be obtained by comparing the change in the concentration of the reactants with the change in the rate of the reaction.

Examples

(a) Determination of the order of reaction for the decomposition of H_2O_2 (Hydrogen peroxide).
A fixed volume of hydrogen peroxide solution is pippetted. A known fixed volume of sodium hydroxide solution ($1cm^3$) is added followed by a known fixed volume of iron (III) chloride solution and the stop clock is started. The flask is swirled and allowed to stand for 3 minutes. $20cm^3$ of 1M H_2SO_4 solution is added which now stops the reaction. The amount of H_2O_2 remaining undecomposed is then determined by titration with a standard solution of potassium permanganate. The experiment is repeated but the decomposition is allowed for 6, 9, 15, 18 minutes before adding the sulphuric acid.
Since the volume of H_2O_2 solution remaining at a given time is proportional to the volume of potassium permanganate solution used up. A graph of volume of Potassium permanganate used up against time is plotted. The order of reaction is determined from the graph by half life method.

(b) Determination of the order of reaction with respect to iodine in the iodination of propanone catalyzed by $H_2^{SO}{}_4$
Fixed volumes of propanone and sulphuric acid ($250cm^3$ each) are measured into a clean flask. Then a fixed volume of standard solution of Iodine ($50cm^3$) is added to the flask and the stop clock is started. The flask is whirled (shaken) and left to stand for 5 minutes. Then a fixed volume ($10cm^3$) of this mixture is pipette and then added to a solution of $NaHCO_3$ which now stops the reaction. The resultant mixture is then titrated with a standard solution of Sodium thiosulphate to determine the amount of Iodine left. The procedure is repeated for 10, 15, 20, 25, 30 minutes before adding sodium hydrogen carbonate.
The titer values are recorded at given time intervals and are proportional to the concentration of Iodine left at those times. A graph of volume of sodium thiosulphate solution against time is plotted. From the graph the order of reaction is determined by half life method.

(c) Determination of order of reaction with respect to sodium hydroxide in the hydrolysis of ethylethanoate.
$CH_3COOCH_2CH_3 + NaOH\ (aq) \rightleftharpoons CH_3CH_2OH + CH_3COO^-Na^+$

Equal fixed volumes of NaOH and ethylethanoate are mixed and kept in a thermostat (to maintain uniform temperature). The change in concentration of the alkali is determined by withdrawing fixed volumes of the mixture at regular time intervals and then added to an excess of a standard solution of hydrochloric acid. The amount of the alkali that reacted is then determined by back titration with a standard solution of NaOH. By calculating backwards the concentration of NaOH solution at various time is noted. A graph of concentration of sodium hydroxide solution left against time is plotted. The order of reaction is then determined by half life method from the graph.

(d) Determination of order of reaction with respect to hydrogen peroxide when it reacts with potassium iodide in acidic media.

$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow H_2O_{(l)} + I_2(aq)$

The order of reaction with respect to H_2O_2 is determined as follows;

A known volume of standard potassium iodide is mixed with a known volume of standard hydrogen peroxide, standard sodium thiosulphate solution and starch indicator then a known volume of standard acid is added and the clock started at once. The time for the blue-black colour to form is recorded. The experiment is repeated using a different volume of hydrogen peroxide but water is added to keep the total volume of the peroxide constant.

By comparing the change in volume of hydrogen peroxide with the change in reciprocal of time (rate of reaction) the order of reaction with respect to hydrogen peroxide can be obtained.

NB: When the order of reaction with respect to H_2O_2 is got the experiment is repeated by changing the volume of potassium iodide solution while leaving other volumes constant.

Theories of chemical reactions

(a) **Collision theory**

This describes a reaction in terms of collisions between the reacting molecules.

Consider

$A_2(g) + B_2(g) \longrightarrow 2AB(g)$



During the collision the whole of A-A bonds and B-B bonds are broken while simultaneously A-B bonds form. The rate of reaction is directly proportional to the number of collisions that occur in a given time interval.

NB:

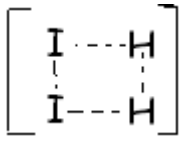
(i) Calculations show that at room temperature and 1 atmosphere pressure approximately 10^{31} Collisions per litre occur in one second.

(ii) Not every collision leads to a reaction taking place. Usually a number of collisions that produce reactions called effective collisions. These collisions are only a very small fraction of the total number of collisions. There are two reasons for this;

(A) The molecules may be improperly aligned or oriented towards each other when they collide. The most favourable orientation is when the axes of the molecules are parallel. e.g.

$I_2(g) + H_2(g) \rightleftharpoons 2HI(g)$

slow fast

$I_2(g) + H_2 \rightleftharpoons$  $\longrightarrow 2HI$

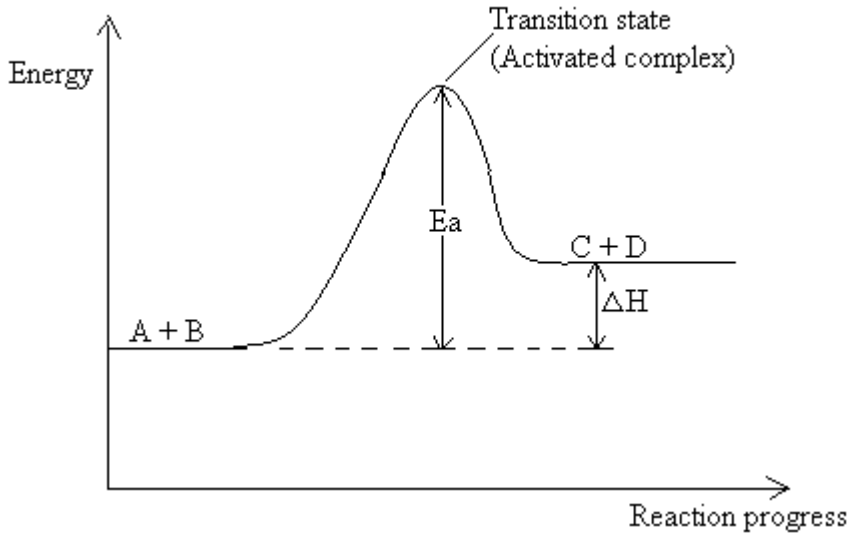
The activated complex is at a higher energy because its formation is accompanied by increase in potential energy of the system (K.E. is converted to P.E).

(b) The collision may be so gentle that molecules rebound unchanged due to repulsions between the electron cloud. Fast moving molecules are not deterred (stopped) by these repulsions. This explains why increase in temperature increases the rate of a reaction and is true for both endothermic and exothermic reactions. i.e. only particles that posses a certain minimum amount of energy or more called the activation energy are able to react.

Activation energy is the minimum amount of energy required by colliding particles to initiate a chemical reaction.

(c) **Transition state theory**

According to this theory a chemical reaction occurs when the particles of the reactants form an unstable intermediate called the activated complex. An activated complex is formed when the reactant particles collide with enough energy so that the electron clouds can interpenetrate.
The minimum energy possessed by reactant particles to overcome the inter-electronic repulsion so that the electron clouds can interpenetrate each other to form an unstable intermediate is called the activation energy.
The energy changes involved in a chemical reaction can be shown using an energy profile. The energy profile for $A + B \rightarrow C + D$

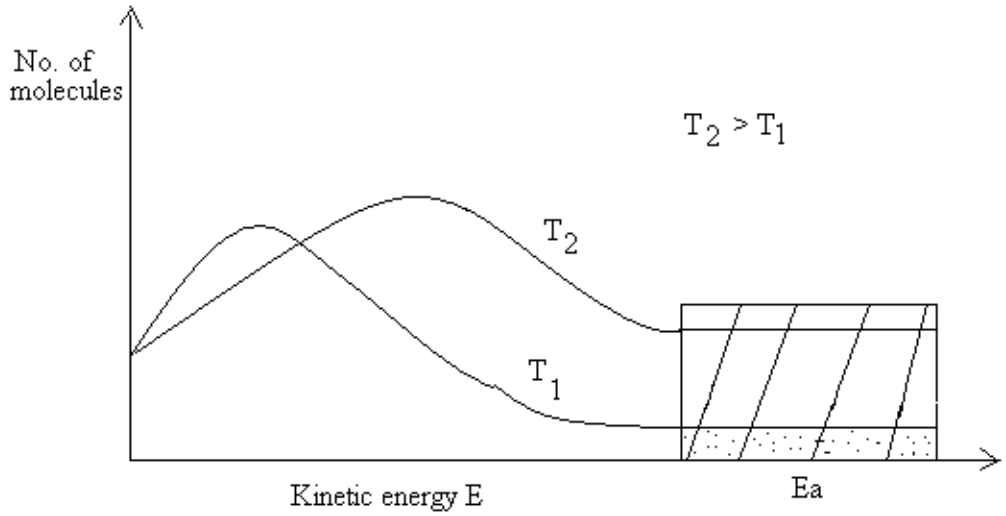


Ea - activation energy.
ΔH - enthalpy change

Factors that affect the rate of reaction.

There are several factors that affect the rate of a chemical reaction. These include
(a) Temperature: Increase in temperature leads to increase in the rate of reaction. This is because when temperature increases the kinetic energy of the reactant particles increases leading to an increase in the rate of collision of the particles.
NB: explanation ends here.

The figure below shows how the distributions of molecular kinetic energies of gas changes with temperature increase.



Fractions of molecules with E>Ea at T_1

Fractions of molecules with E>Ea at T_2

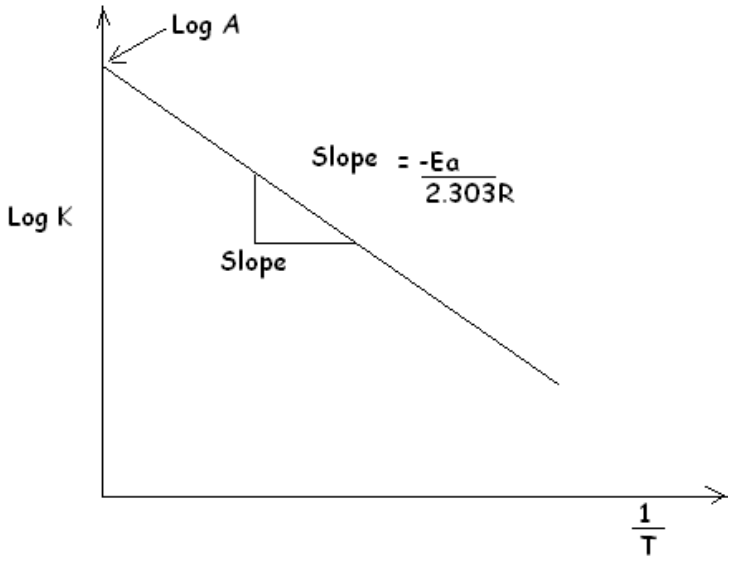
At T_2 the number of molecules with energy, E grater than activation energy, Ea is greater than those at T_1. Therefore, more molecules react thus increase in the rate of reaction.
Since the rate of reaction with temperature dependent, then the rate constant is temperature dependant also. According to Arrhenius

$K = Ae^{-Ea/RT}$

$$\ln K = -Ea/RT + \ln A \quad \text{or} \quad \log K = -Ea/2.303RT + \log E$$

Where R = gas constant
A = Arrhenius constant

A plot of Log K against $1/T$ is as below;



Activation energy can be determined if rate constants are known at two different temperature. E.g. If K_1 and K_2 are the rate constants at T_1 and T_2 respectively.

$$\therefore \quad \log \frac{K_2}{K_1} = \frac{-Ea}{2.303R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

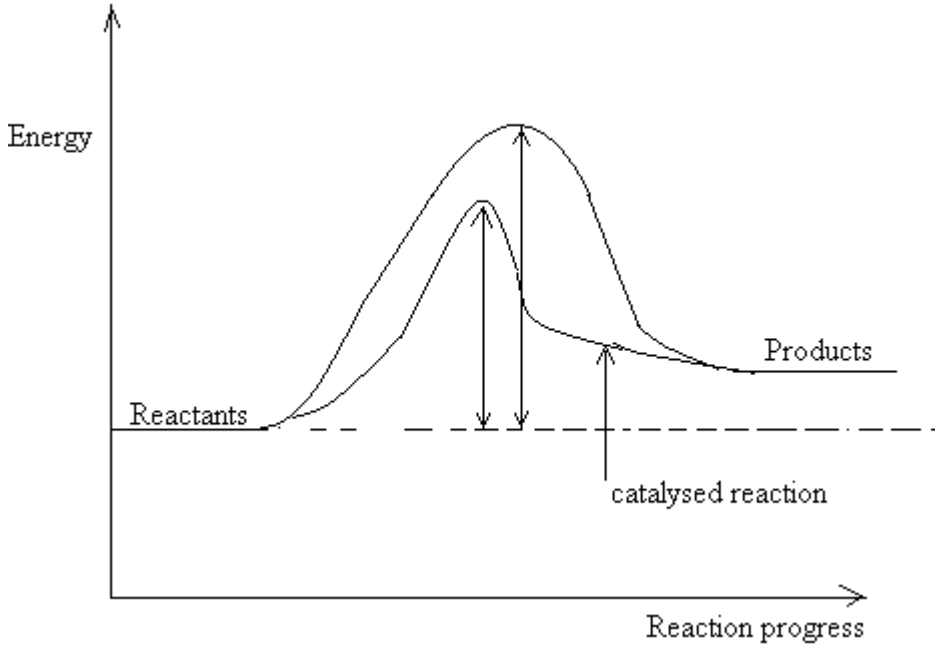
NB: Rate constant like equilibrium constant is affected only by temperature.

(b) Pressure for the reactions involving gases. The rate of the reaction increases with increase in pressure, this is because increase in pressure brings the reactant particles closer together leading to an increase in the rate of collision.

(c) Concentration of the reactants. Increase in concentration results into increase in rate of reaction. The higher the concentration of the solution, the higher the rate of the reaction. Since the rate of collision increases with increase in concentration.

(d) Surface area of solid reactants:
Solid particles with a big size are less reactive than small sized particles, this is because the surface area that is exposed to another reactant in case of a big sized particle is smaller than that of a small sized particles.

(d) Addition of a catalyst – a catalyst is a substance that increases the rate of a chemical reaction and remains chemically unchanged at the end of the reaction. The catalyst increases the rate of a chemical reaction by lowering the activation energy of the reactants. As the activation energy is lowered, the number of reactant particles that can form the activated complex increases.



REACTION MECHANISM

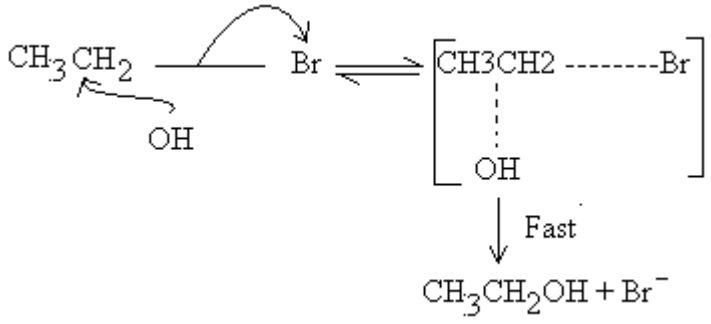
A chemical reaction can pass through a series of steps before it reaches completion, the series of steps through which a reaction goes before it reaches completion is called the reaction mechanisms. Some steps in the reaction mechanism are slower than others. The slowest step in the reaction mechanism is the rate determining step.
The number of the reactants species involved in the slowest step of the reaction mechanism is called the molcularity of the reaction.

Examples

(a) A primary alkyl halides and secondary alkyl halides undergo nucleophilic substitution when they are heated with sodium hydroxide solution e.g.

$$CH_3H_2Br \xrightarrow[\text{Heat}]{NaOH(aq)} CH_3CH_2OH + NaBr$$

Mechanism



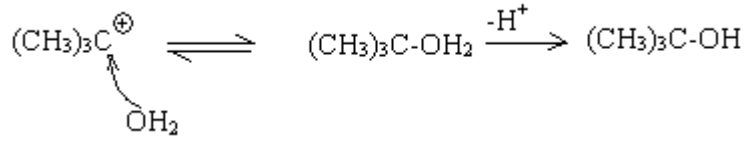
In the above mechanism the slowest step involves two reactants, i.e. the alkyl halide and the hydroxide, therefore the molecularity of the above reaction is two (2).

(b) Tertially alkyl halides undergo hydrolysis when boiled with water.

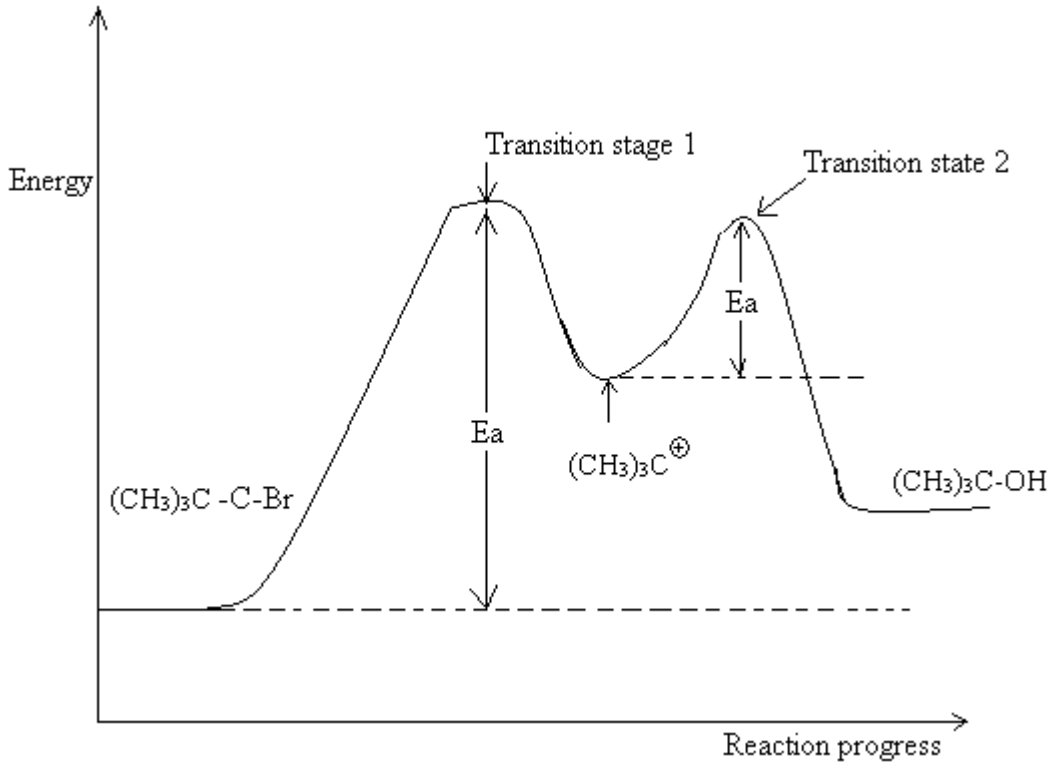
$$\begin{array}{l} CH_3 \\ \quad | \quad\quad H_2O \\ CH_3 - C - Br \xrightarrow[\text{boil}]{} (CH_3)_3C - OH + HBr \\ \quad | \\ CH_3 \end{array}$$

Mechanism

$$(CH_3)_3C{-}Br \rightleftharpoons (CH_3)_3C^+ + Br^-$$



In the above mechanism the slowest step involves one reactant, therefore the molecularity of the above reaction is one, the energy profile for the reaction is as shown below;



Where Ea = activation energy for the bromalkane

Ea^1 = Activation energy for the carbonium ion

NB:

The molecularity of the reaction is not necessarily equal to the order of the reaction. However, when the order of the reaction is one, the rate of the reaction depends on only one reactant and hence the molecularity of the reaction is one.

Economics

PRICE THEORY

Price theory is a microeconomics principle that involves the analysis of demand and supply in determining an appropriate price point for a good or service.
This section is concerned with the study of prices and it forms the basis of economic theory.

PRICE DEFINITION

Price is the exchange value of a commodity expressed in monetary terms.
OR
Price is the monetary value of a good or service.
For example the price of a mobile phone may be shs. 84,000/=.

PRICE DETERMINATION

Prices can be determined in different ways and these include;

1. **Bargaining/ haggling.**

This involves the buyer negotiating with the seller until they reach an agreeable price. The seller starts with a higher price and the buyer starts with a lower price. During bargaining, the seller keeps on reducing the price and the buyer keeps on increasing until they agree on the same price.

2. **Auctioning/ bidding**
   This involves prospective buyers competing to buy a commodity through offering bids. The commodity is usually taken by the highest bidder.
   This method is common in fundraising especially in churches, disposal of public and company assets and sell of articles that sellers deem are treasured by the public.
   Note that the price arising out of an auction does not reflect the true value of the commodity.
3. **Market forces of demand and supply.**
   In this case, the price is determined at the point of intersection of the market forces of demand and supply. This is common in a free enterprise economy. The price set is called the equilibrium price.
4. **Fixing price by treaty/ agreement.**
   This involves the buyer sitting with the seller to negotiate and fix the price at which a good or service shall be sold and the price remains fixed. The price agreed upon at the time of signing the agreement can be changed or revived by amending the treaty. For example hire purchase and deferred payments agreement, rental agreements, land purchase agreements
5. **Price leadership**
   This is the setting of price by either a leader firm or low cost firm in the industry and other firms follow by charging the same price. This form of price determination is common in oligopolistic firms.
   Price leadership takes on the following forms;
   - Dominant price leadership
   - Barometric price leadership
   - Aggressive or exploitative price leadership
6. **Price legislation/ control/ administration.**
   This is where the government fixes prices of commodities that is either a maximum price to protect consumers or a minimum price to protect producers.
7. **Offers at fixed prices**
   This is where individuals, government and institutions set the price at which a commodity is to be sold and whoever is to buy from them must pay the fixed price. For example UNEB fixes prices for its examinations, UMEME for a unit of electricity, NWSC for a litre of piped water, in super markets.
8. **Collusion.**
   This involves sellers agreeing on the price to charge the buyers. It is common when there are few sellers who wish to reduce competition among them and avoid price wars.
   For example different operators of bus services can collude or agree to charge a uniform transport fare from passengers on given routes along which their buses operate.
9. **Resale price maintenance.**
   This is a mechanism of price determination where manufacturers set the prices at which their commodities are to be sold to the final consumers by retailers. The price is usually written on the commodity. In Uganda, resale price maintenance is practiced by;
   - Post office on stamps
   - The press industry on newspapers
   - The telecommunication network industry on airtime cards, simpacks and phones on promotion.

MERITS OF RESALE PRICE MAINTENACE

1. Ensures price stability in the market.
2. Stabilises income and profits of retailers
3. Protects small retailers from being outcompeted by large scale retailers.

4. Saves time which would have been spent on bargaining.
5. Enables producers to easily calculate their revenue from sales.
6. Reduces consumer exploitation in form of increased prices by sellers/ retailers.
7. Facilitates the collection of taxes by government because prices are stable.
8. Enables consumers to make consumption plans/ budgets.

CLASSIFICATION OF PRICE

Price may be classified into;

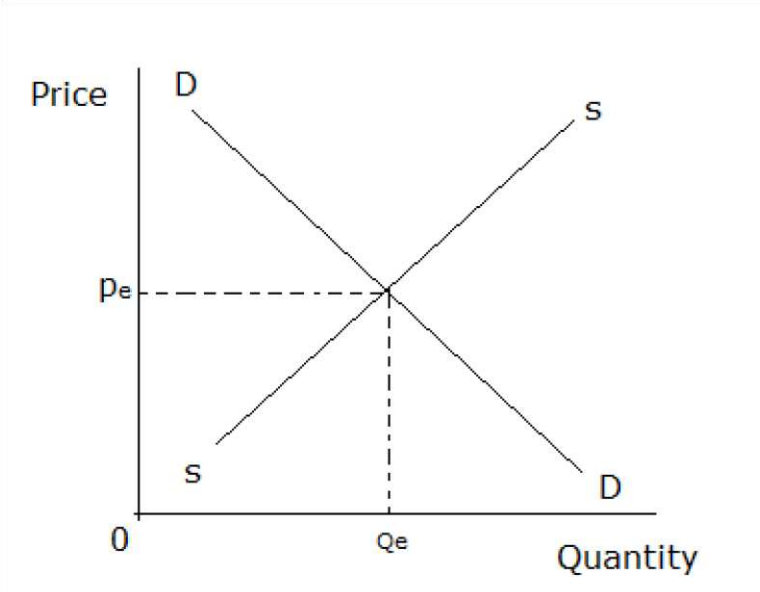
a) Market price

This is the ruling/ prevailing price in the market at a particular time determined by buyers and sellers. This price changes from time to time since it is determined by a number of factors. **b) Equilibrium price**

This is the price at which quantity demanded is equal to quantity supplied in the market.

The equilibrium quantity and price are got at the point of intersection of the demand and supply forces.

Illustration



OP_e is the equilibrium price.

a) Normal price

Is the price attained/ obtained when quantity demanded equals quantity supplied in the long run.

OR

This is the long run equilibrium price that persists in the market when supply and demand conditions have settled. It is an ideal price which may never be realized and the market price tends to oscillate around it.

b) Reserve/ reservation price.

Is the least/ minimum/ lowest price a producer/ seller is willing to accept in exchange of his/ her commodity below which he/ she retains the commodity.

DETERMINANTS OF RESERVE PRICE

1. **Expected future demand for a commodity.**

   A producer who expects demand for his commodities to increase in the nearby future sets a high reserve price to retain many goods for sell in the future when demand increases while a producer who expects demand for his commodities to fall in the nearby future sets a low reserve price currently so as to sell off the commodity very fast before demand falls.
2. **Expected future price of the commodity.**

A seller who expects the future price of the commodity to increase sets a high reserve price so as to retain many goods for sell at a higher price in the future. However, sellers expecting reductions in future prices set low reserve prices such that they sell more currently and avoid the lower prices in the future.

3. **Nature of the commodity (perishable goods vs durable goods)**
   A seller dealing in durable goods sets a high reserve price because his goods are long lasting and can remain in good condition even when not bought urgently. However, a seller who deals in perishable goods sets a low reserve price to sell off the goods before they go bad.
4. **Degree of necessity of the commodity.**
   Sellers dealing in commodities with a high degree of necessity set high reserve prices because they know that consumers cannot do without them. However, sellers dealing in commodities with a low degree of necessity set low reserve prices because they know that consumers can do without them.
5. **Size of transport (carriage) and storage charges.**
   High storage and transport charges lead to a low reserve price because the seller wishes to sell off the commodity very fast before incurring more of these charges. However, low transport and storage charges lead to a high reserve price because the seller is not scared of transporting or storing goods for a long period of time.
6. **The length of the gestation period**
   A long gestation period leads to a high reserve price because the producer is aware of the inconveniences he/ she is going to go through to produce the next commodities. However, a short gestation period implies that the seller needs less time to produce the commodity and therefore he sets a low reserve price.
7. **Level of liquidity preference of the producer/seller.**
   Sellers with urgent need for cash (high liquidity preference) set low reserve prices to ensure that they actually sell the goods for the money they need. However, sellers with no urgent need for cash (low liquidity preference) set high reserve prices.
8. **The cost of production.**
   Producers who incur high costs of production set high reserve prices because it is expensive for them to replace the sold goods. However, producers who incur low costs of production set low reserve prices because it is cheap for them to replace the sold goods.

NB

1. Gestation period is the time it takes before new supplies of goods reaches the market for example maize takes 3-4 months while mushrooms take 1 month.
2. Liquidity preference (demand for money) is the desire by individuals to hold assets/ wealth in cash form or near cash form (rather than investing it).

ASSIGNMENT

Explain the factors that lead to high reserve price.

FACTORS THAT INFLUENCE PRICING OF GOODS AND SERVICES

1. **Forces of demand and supply.**
   As supply exceeds demand, low prices are set due to a surplus of commodities on the market. However when demand exceeds supply, high prices are set for commodities because they are scarce.
2. **Aim/ objective of the producer.**
   Where producers aim at profit maximization, they restrict output charge a high price and where producers aim at sales maximization, they charge relatively lower prices to encourage people to buy as much quantities as possible.
3. **Cost of production.**

High cost of production leads to a high price set since producers aim at profit maximization and low cost of production leads to a low price set for the commodity.

4. **Rate of taxation.**
   Heavy taxes imposed on goods and services lead to high prices set since producers tend to shift the burden of paying taxes to consumers in form of increased prices. However, low taxes imposed on goods and services lead to low prices set.
5. **Quality of the commodity.**
   High quality goods are highly priced since producers incur high costs in producing them while low quality goods are lowly priced as they are cheap to produce.
6. **Elasticity of demand for a commodity.**
   Producers set high prices for commodities whose demand is price inelastic since people continue to buy even if prices increase and they set low prices for those whose demand is price elastic since any slight increase in price results a big fall in quantity demanded.

USES OF PRICE IN A MARKET ECONOMY

- It is used to determine what to produce.
- It is used to determine how to produce.
- It is used to determine where to produce. It is used to determine for whom to produce It is used to determine when to produce.
- It is used to determined how much to produce.
- It is used to determine the value of a good.

THE MARKET CONCEPT

A market is a mechanism/arrangement in which buyers and sellers come into contact and exchange goods and services.

A market where goods and services are traded is known as a **commodity market.**

FEATURES OF A MARKET

- There should be sellers and buyers
- There should be an interaction between sellers and buyers.
- There should be a commodity to be exchanged.
- There should be an established medium of exchange.

DEMAND THEORY

DEFINITIONS

Demand is the desire backed by the ability to pay a given amount of money for a particular amount of a commodity in a given period of time.

OR

Demand is the amount of a good that a consumer is willing and able to buy at a given price in a given period of time.

Effective demand is the actual buying of goods and services at a given time.

TYPES OF DEMAND

1. **Joint/ complementary demand.**
   This is the demand for commodities which are used together; an increase in the demand for one commodity leads to an increase in the demand for the other commodity.
   Examples of joint demand include;
   - Demand for cars and fuel
   - Demand for DVD players and DVDs.
   - Demand for guns and bullets
   - Demand for cameras and films
   - Etc
2. **Competitive demand.**

This is the demand for commodities which serve the same purpose; an increase in the demand for one commodity leads to a decrease in the demand for the other commodity. Examples of competitive demand include;

- Demand for butter and honey
- Demand for bread and cakes
- Demand for tea and coffee
- Demand for Omo and Nomi
- Demand for close up and fresh up
- Demand for beans and peas
- Etc

3. **Independent demand.**

This refers to demand for commodities which are not related such that the demand for one commodity does not directly affect the demand for another commodity. Examples of independent demand include;

- Demand for clothes and food
- Demand for a car and a pen
- Etc

4. **Composite demand**

This is the total demand for a commodity which has several/ many uses.
Examples of composite demand include;

- Demand for electricity (for lighting, ironing, cooking, etc)
- Demand for water (for cooking, bathing, etc)
- Demand for timber (for construction, furniture making, manufacturing, etc)
- Demand for cotton wool (for cloth making, cushioning, cleaning, etc)
- Demand for steel (for manufacturing machines, motor cars, roofing, etc)
- Demand for clay (for making pots, bricks, cups, etc)
- Demand for an axe (for splitting wood, tool of defence, etc)
- Demand for skins and hides (for making shoes, bags, belts, etc)
- Demand for paper (for making books, bank notes, envelopes, toilet paper, etc)
- Demand for cloth (for adornment, protection, etc)

5. **Derived demand.**

This is the demand for a commodity not for its own sake but for the sake of what it helps to produce.
OR
It is the demand for a commodity due to the demand for the commodity that it helps to produce.
Examples of derived demand include;

- Demand for land
- Demand for labour
- Demand for capital □ Demand for entrepreneurship □ Demand for organisation.

ASSIGNMENT

1. a) What is composite demand? (01 mark)
   b) State any three examples of commodities with composite demand in your country.
   (03 marks)

THE DEMAND SCHEDULE

This is a table showing the amount of a commodity demanded at various prices by a consumer or groups of consumers during a particular period of time. This schedule can be compiled either for an individual or for all individuals in the market.

INDIVIDUAL AND MARKET DEMAND SCHEDULES

Price (in Shs. Per kg)	Quantity demanded By Consumer A	Quantity demanded by Consumer B	Market demand (in kg)
5,000	40	20	60
4,000	60	40	100
3,000	80	60	140
2,000	100	80	180
1,000	120	100	220

The market demand schedule is derived by horizontal summation of the quantities purchased at each price by all the individuals / consumers in the market. The quantities in the market schedule are larger than those of the individuals demand schedule.

One major characteristic of a demand schedule is that the higher the price the lower the quantity demanded and the lower the price the higher the quantity demanded of the commodity in question other factors being constant.

The information tabulated in a demand schedule can be summarized or represented graphically on a curve

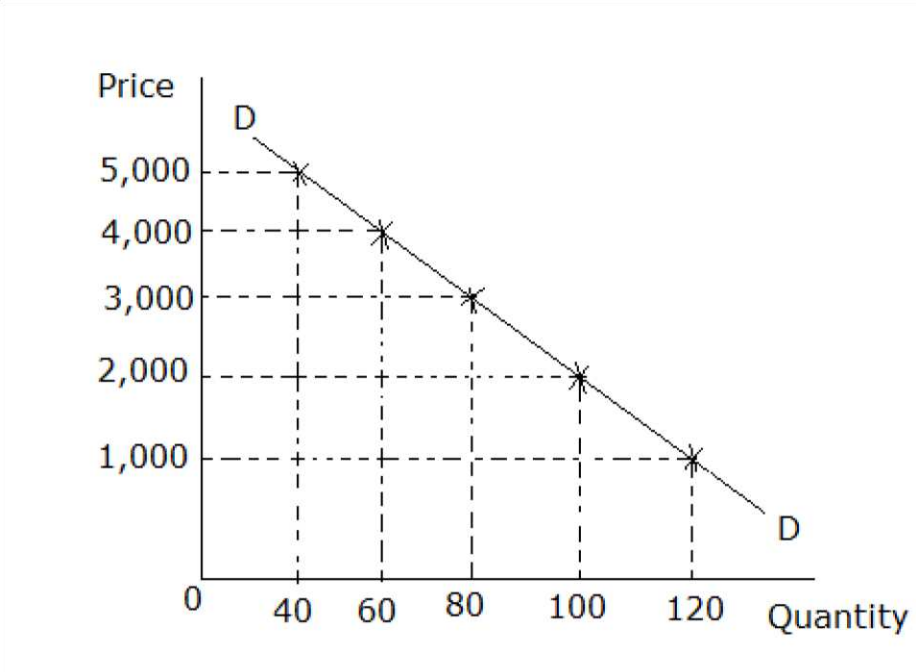
THE DEMAND CURVE

The demand curve is a graphical representation of the demand schedule.

The demand curve is a locus of points showing the quantities demanded of a commodity at various prices in a given period of time.

Price is represented on the vertical axis while quantity demanded is on the horizontal axis.

From the above table, an individual demand curve (Consumer A) can be drawn as shown below.



A normal demand curve is downward sloping from left to right, that is it has a negative slope meaning that there is an inverse relationship between price and quantity demanded. (As the price increases, quantity demanded decreases and vice versa).

QUALITIES OF A NORMAL DEMAND CURVE

1. It must be downward sloping from left to right.

2. It should not touch either of the axes. If it touches the Y-axis, it implies that a consumer incurs a cost for a commodity which has not been obtained. (He pays a price at zero quantity). If it touches the X-axis, it implies that the consumer is buying a commodity at zero prices.

THE LAW OF DEMAND

The law of demand states that "the higher the price of a commodity, the lower the quantity demanded and the lower the price of a commodity, the higher the quantity demanded holding other factors constant (Ceteris paribus).

REASONS WHY THE DEMAND CURVE SLOPES DOWNWARDS FROM LEFT TO RIGHT (EXPLAINING THE LAW OF DEMAND)

A normal demand curve is one that slopes downwards from left to right following the law of demand. The following reasons explain why the demand curve slopes downwards from left to right.

1. **The law of diminishing marginal utility**

According to this law, when a consumer buys more units of the commodity, the marginal utility of that commodity continues to decline; and therefore the consumer will buy more units of the commodity only when the price reduces. When fewer units are available, utility will be high and the consumer will be prepared to pay more for that commodity. This proves that demand will be low at a higher price and that is why the demand curve is downward sloping.

2. **The substitution effect of a price change.**
   When the price of the commodity falls, the price of substitutes remaining the same, a consumer reduces the quantities of other substitute goods whose prices now appear relatively high and increases the quantity of the commodity whose price has fallen. When the price of the commodity under consideration increases, the consumer leaves the commodity and buys the substitutes, given constant prices of substitutes hence the downward sloping demand curve.
3. **The income effect of a price change. (Real income effect)**
   When an individual has a fixed income and the price of the commodity reduces, his real income increases and hence he can buy more units of the commodity with his fixed income. On the other hand when the price increases, the consumer's real income decreases and hence he buys less units of the commodity hence the downward sloping demand curve.
4. **The total effect of a price change.**
   This is the combination of the substitution and income effects. When the price of the commodity falls, the quantity demanded increases because many new buyers are attracted while an increase in price leads to a decrease in demand because it scares away buyers hence the inverse relationship between price and quantity demanded which produces a downward sloping demand curve.
5. **Behaviour/presence of low income earners.**
   The demand curve depends upon the behaviour of low income earners. They buy more when price reduces and less when the price increases. This leads to a downward sloping demand curve. (The rich do not have effect on the demand curve because they are capable of buying the same quantity even at a higher price)
6. **Different/various uses of certain commodities.**
   Some goods have more than one use e.g. water, electricity, etc such that when the price of the commodity increases, consumers tend to use it for essential purposes only hence reducing on its

demand. On the other hand when the price reduces, the consumers put the commodity to many uses thereby increasing quantity demanded hence a downward sloping curve.

DETERMINANTS/ FACTORS INFLUENCING/ AFFECTING DEMAND.

1. **Price of the commodity in question.**
   A high price leads to low demand because it scares away some buyers. However, a low price attracts new buyers hence high commodity demand.
2. **Price of substitutes.**
   A high price of substitutes leads to high commodity demand because the commodity appears relatively cheaper. On the other hand, a low price of substitutes leads to low commodity demand because the commodity appears to be relatively expensive.
3. **Price of complements.**
   A high price of a complement leads to low commodity demand because it is expensive to use both goods together. On the other hand a low price of a complement leads to high commodity demand because it is cheap to use both goods together.
4. **Level of consumer's income.**
   High level of consumer's income leads to high purchasing power hence high commodity demand. However, low level of consumer's income leads to low purchasing power hence low commodity demand.
5. **Tastes and preferences of consumers.**
   Favourable tastes and preferences result in high commodity demand because they are able to raise the consumer's interest in the commodity. However, unfavorable tastes and preferences result into low commodity demand because they make the consumer to develop bias against the commodity.
6. **Size of the market/ population size.**
   A large population size creates high commodity demand because it is associated with many buyers. However, a small population size leads to low commodity demand because it has few buyers.
7. **Nature of income distribution.**
   A fair distribution of income leads to high commodity demand because many people can afford to purchase a commodity. However, high level of income inequality between individuals and different groups of people leads to low commodity demand because there are few people who can afford to purchase the commodity.
8. **Future price expectation.**
   Expectation of a high price in the nearby future leads to high commodity demand currently because buyers stock more goods to avoid the higher prices in the future. However, expectation of a low price in the nearby future leads to low commodity demand currently because the buyer reserve some money so as to buy more when the price falls.
9. **Government policy on taxation.**
   High level of direct taxation leads to low commodity demand because people have low disposable income while low level of direct taxation leads to high commodity demand because people have high disposable income.
10. **Seasonal factors.**
    Certain commodities are demanded in particular seasons. Favourable season leads to high commodity demand and unfavourable season leads to low commodity demand. It is common to see vendors selling success cards during examination periods, Christmas cards in Christmas period and Easter cards in the Easter period. However outside those periods, one can hardly find them on the market because no one is willing to purchase them.
11. **Level of advertising.**
    A high level of advertising leads to high commodity demand because it results into high level of awareness of the consumers about the availability of the commodity. On the other hand, low level of

advertising leads to low commodity demand because it leads to low level of awareness of the consumers about the availability of the commodity.

12. The prevailing economic conditions in an economy.

Commodity demand tends to be high during periods of economic prosperity (boom) because during such times, people are employed and earn fair income to purchase the commodity. However, commodity demand is low during periods of economic depression because many people have no jobs and thus have no income to purchase the commodity.

13. Quality of the commodity.

A high quality of the commodity encourages people to buy hence high commodity demand while a low quality of the commodity forces people to abandon it hence low commodity demand.

14. Availability of credit facilities.

Commodity demand is high when consumers are allowed to take goods on credit because many consumers without immediate cash are able to buy the commodity. However, commodity demand is low when consumers are not allowed to buy goods on credit because the few buyers with cash are the only ones who buy.

15. The law of diminishing marginal utility.

With high marginal utility, commodity demand is high because the commodity is highly enjoyable and satisfying to the buyer. However at low marginal utility, commodity demand is low because the commodity is less enjoyable and satisfying to the buyer.

16. Socio-economic factors.

These include age, sex, religion, culture etc. One or a combination of these factors to some extent influence demand for a commodity. For instance demand for pork is low in places where there are many Muslims as compared to places where there are many Christians especially Catholics and Pentecostals.

ASSIGNMENT

1. Explain the factors that lead to high demand of a commodity.
2. Explain the factors that lead to low demand of a commodity.

SHIFTS IN DEMAND

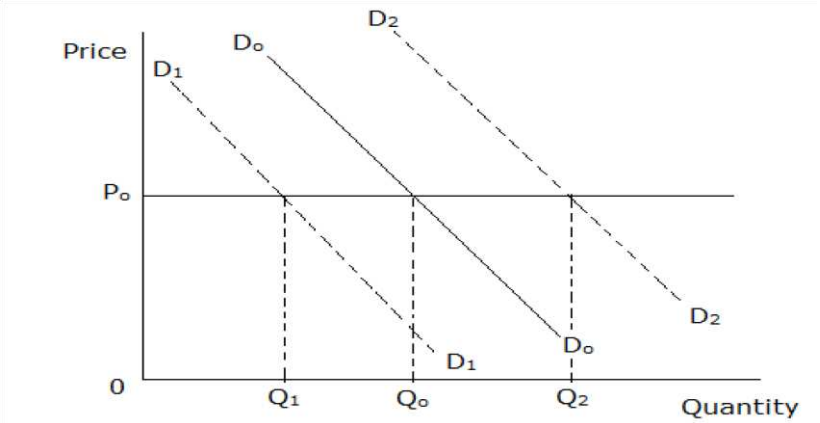
These involve change in demand and change in quantity demanded.

CHANGE IN DEMAND

A change in demand refers to an economic situation where more or less units of a commodity are demanded at a constant price brought about by a change in other factors affecting demand for that particular commodity.

It is illustrated by a total shift of the demand curve either inwards to the left or outwards to the right holding the commodity price constant.

Illustration



From the above illustration, D_OD_O is the original demand curve.

D_1D_1 shows a shift of the demand curve inwards from D_OD_O representing a decrease in demand.

D_2D_2 shows a shift of the demand curve outwards from DoDo representing an increase in demand.

QUESTION

Explain the factors that cause a change in demand for a commodity.

Solution

NOTE

1. The factors that cause a change in demand are generated from the determinants of demand other than the commodity's own price.
2. Words that can be used when stating the point include;
   - Change
   - Variations
   - Instabilities.
3. Avoid words like high/ low in your explanation. Use words like increase, rise, decrease, decline, fall, etc.

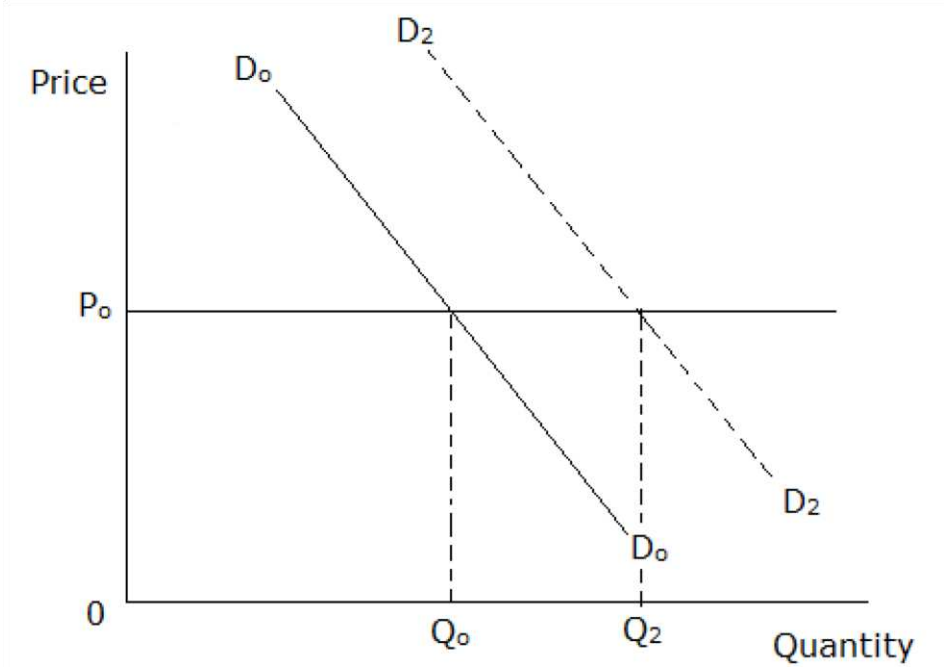
Solutions

1. A change in prices of substitutes.
2. A change in prices of complements.
3. A change in the level of consumer's income
4. A change in the size of the market/ population size/ number of consumers.
5. Expectation of a future change in the price of the commodity. 6. A change in government policy of taxation and subsidization.
7. A change in the level of advertisement.
8. A change in seasons.
9. A change in tastes and preferences 10. A change in the quality of the commodity
11. A change in the economic conditions.
12. A change in the nature of distribution of income.

INCREASE IN DEMAND

This is the demand for more quantities of a commodity due to conditions of demand/ factors that influence demand becoming (more) favourable while holding price of the commodity (in question) constant.

It is represented by a total shift of the demand curve outwards to the right holding the commodity price constant.



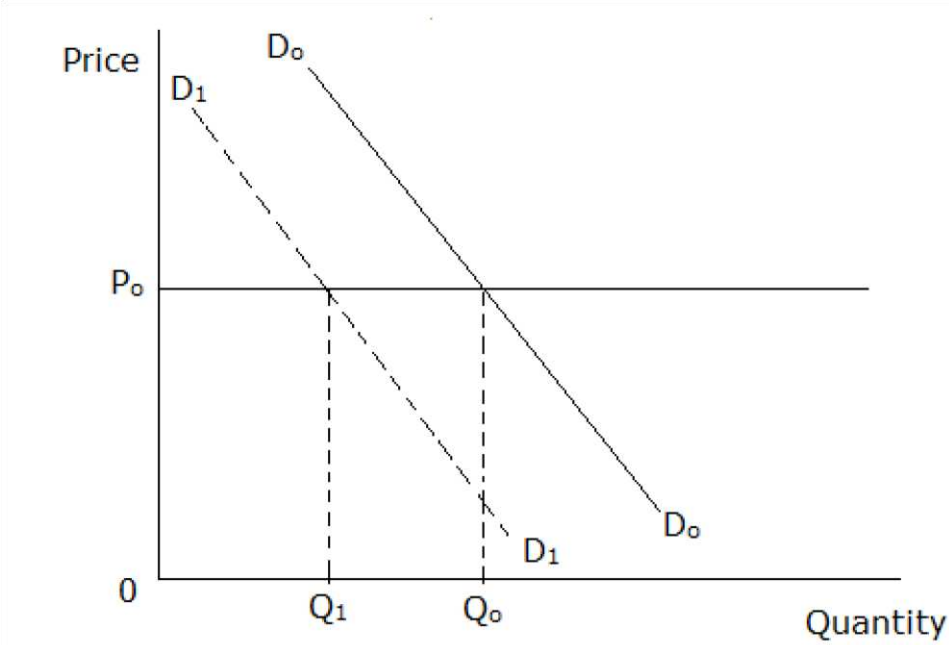
ASSIGNMENT

Explain the factors that lead to an increase in demand for a commodity in your country.
(20 marks)

DECREASE IN DEMAND

This refers to a decline in quantity demanded of a commodity due to factors that influence demand becoming unfavourable while holding price of the commodity (in question) constant.

It is represented by a total shift of the demand curve inwards to the left holding the commodity price constant.



ASSIGNMENT

Account for a decrease in commodity demand in your country (20 marks)

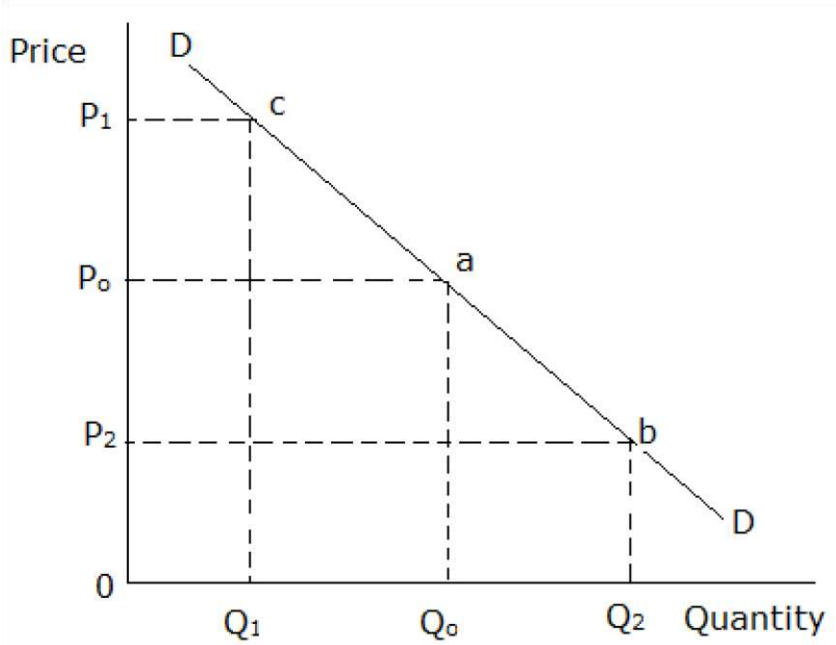
CHANGE IN QUANTITY DEMANDED

This is an economic situation where more or less units of a commodity are demanded due to change in its price when other factors affecting demand for that particular commodity have not changed.

OR

A change in quantity demanded refers to a rise or fall in the amount of a commodity demanded due to changes in price levels of a commodity assuming other determinants of demand are held constant. It is illustrated by the movement along the demand curve either upward due to price increase or downward due to price fall.

Illustration



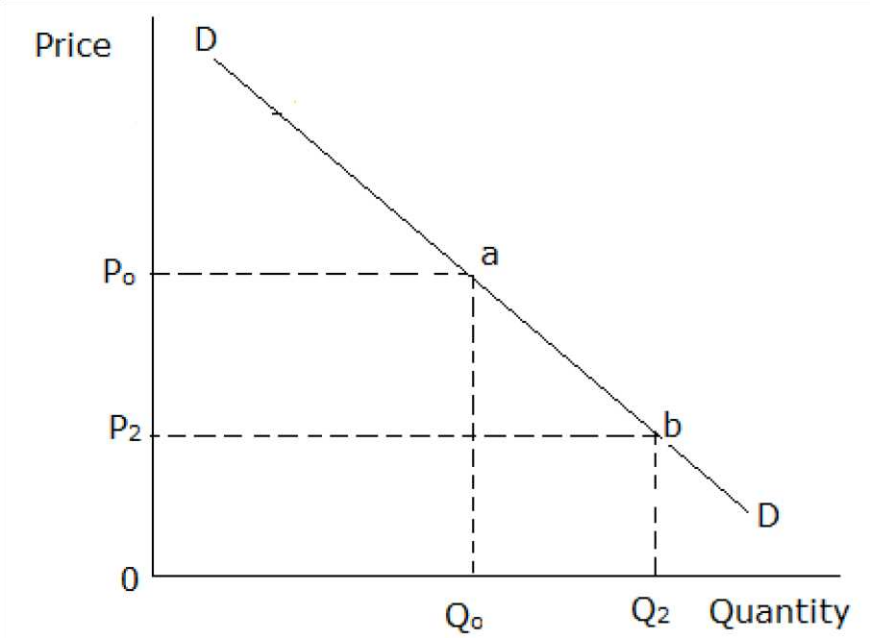
A fall in price from OP_o to OP_2 leads to an increase in quantity demanded from OQ_o to OQ_2 as illustrated by the movement along the demand curve downwards from point a to b.

A rise in price from OP_o to OP_1 leads to a decrease in quantity demanded from OQ_o to OQ_1 as illustrated by the movement along the demand curve upwards from point a to c.

INCREASE IN QUANTITY DEMANDED

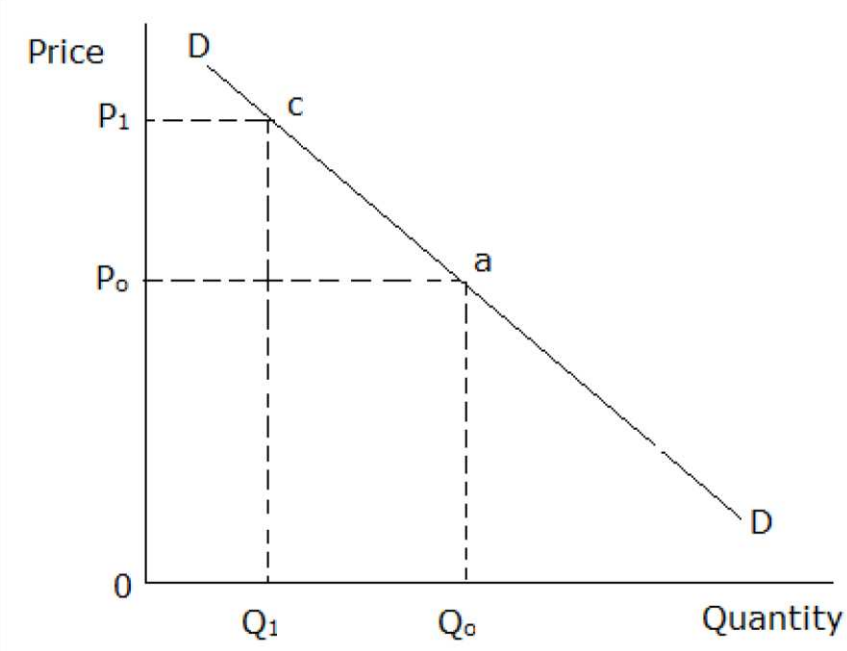
This refers to the demand for more units of a commodity due to a fall in its price while holding other factors constant/ ceteris paribus.

Illustration



DECREASE IN QUANTITY DEMANDED

This refers to the demand for lesser quantity of a commodity due to increase in its price ceteris paribus.



ABNORMAL/ REGRESSIVE/ EXCEPTIONAL DEMAND CURVES

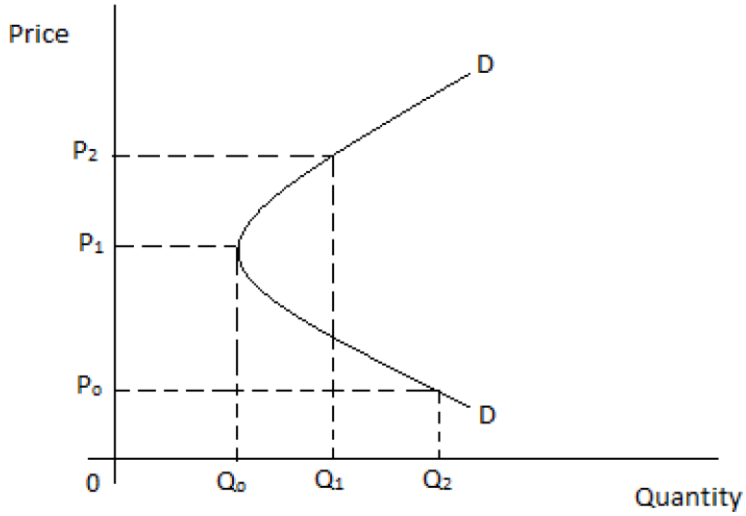
These are curves which do not obey the law of demand which states that the higher the price, the lower the quantity demanded and the lower the price, the higher the quantity demanded ceteris paribus. Such curves take a different shape from the one of the normal demand curve.

The following are the factors that violet the law of demand.

1. **Demand for articles of ostentation/ luxuries/ conspicuous consumption.**

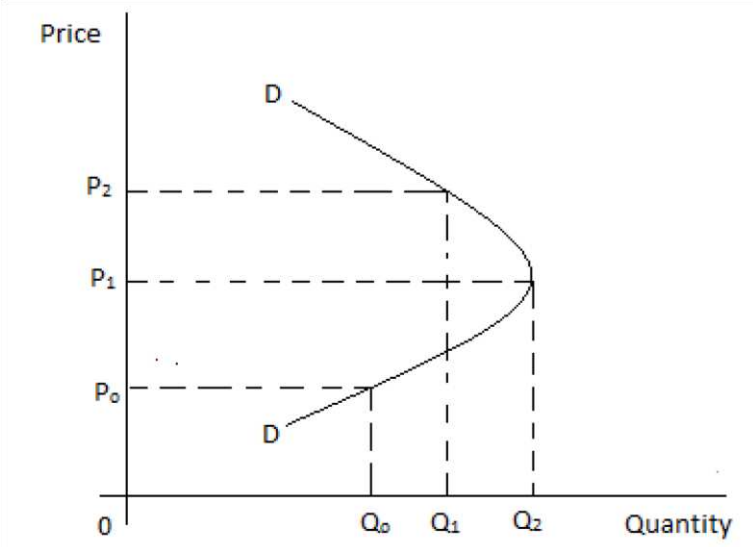
   These are goods bought by the rich people to impress or attract the attention of others for example sports cars, golden earrings. More of such goods are demanded at a higher price than at a lower price.

   The demand curve for luxuries is regressive at the upper level.



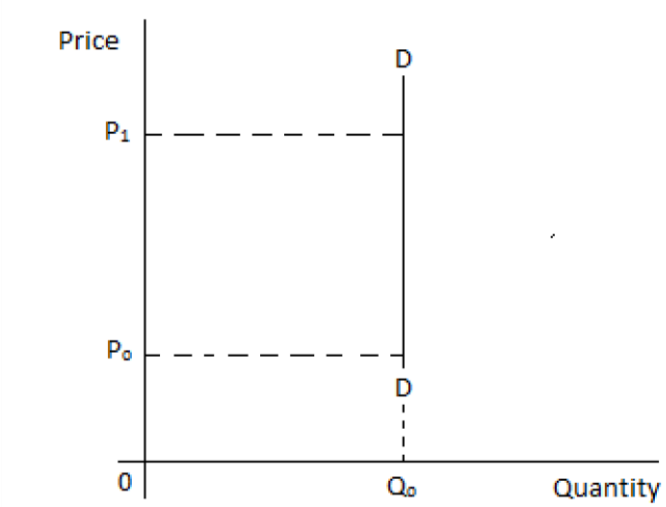
The quantity demanded is very high at a low price. As the price increases to an average price, the quantity demanded reduces so much because many poor people can no longer afford. As the price increases further to a very high price, the quantity demanded increases because all the rich people start buying the commodity.

2. **Demand for giffen goods.**
   These are inferior goods which take a large proportion of the budget of low-income earners such that when their prices increase, the consumer reduces the consumption of other goods and buys the giffen good. Examples of giffen goods are the basic foodstuffs such as rice, maize, bananas and cassava.
   For these giffen goods, the demand curve is regressive at the lower level such that if prices over increase, consumers have to lower the demand altogether.



An increase in the price from OP_o to OP_1 causes an increase in amount demanded i.e. from $OQ_o$to OQ_2.

3. **Demand for necessities.**
   Goods which are very essential tend to have a fixed demand at different price levels. E.g. salt.



4. **Speculation (future price expectations)**
   When consumers expect a future price increase, they buy more units of the commodity in the current period even if the commodity's price is high. On the other hand, when they expect a future price fall, they buy less units of the commodity even if its price is low hence violating the law of demand.
5. **Ignorance effect.**
   Some consumers may buy more units of the commodity at high prices due to information asymmetry/ market imperfection. Some also buy the more expensive item because they believe it to be of better quality.
6. **Effect of an economic boom or depression.**
   In times of a depression, fewer quantities of goods are purchased even when their prices are reduced. This is because in times of an economic depression, purchasing power is very low. In times of an economic boom, more quantities of goods are purchased even when their prices are increased. This is because in times of an economic boom, purchasing power is very high. In both cases, the demand curve is positively sloped.
7. **Addiction to the consumption of the commodity.**
   Consumers who are addicted to consumption of particular commodities normally buy the same quantities of the good even if the price increases e.g. smokers.
8. **Special seasons.**
   For example Christmas season, Iddi season, in such seasons, people can afford to buy goods at high prices due to the high need for them.

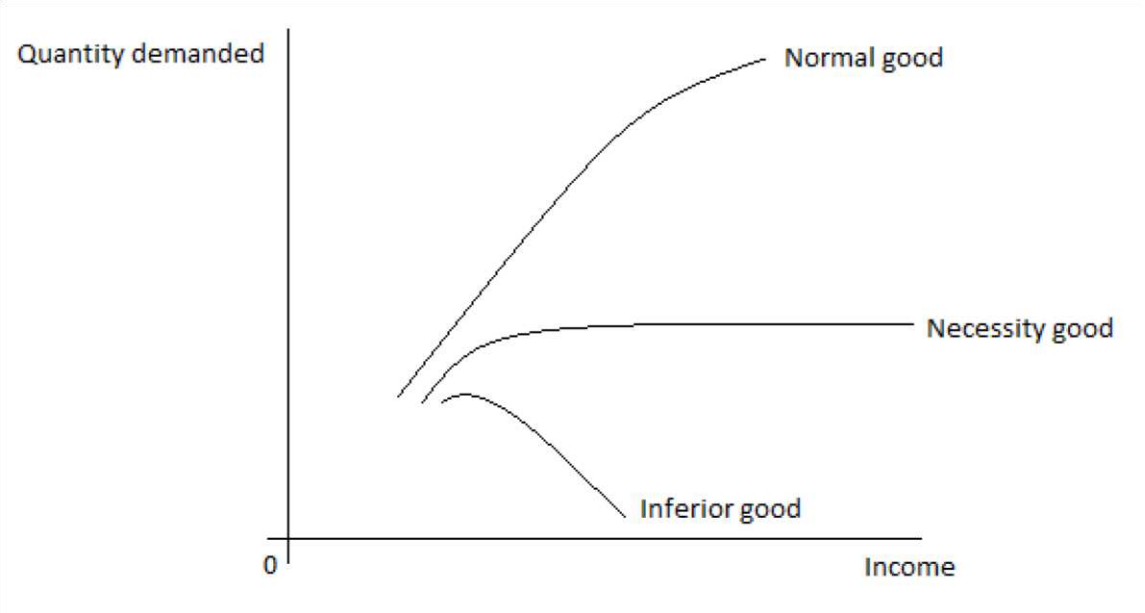
Assignment

a) Define the term **market demand.**
b) State the determinants of market demand in an economy.

ENGEL CURVE

This is a curve that describes how household expenditure on a particular good or service varies with household income. It was named after the German statistician Ernst Engel (1821 – 1896) who was the

first to systematically investigate the relationship between demand and income of the consumer in 1857.



From the diagram above, the following can be observed.

1. For normal goods, the Engel curve has a positive gradient. That is as income increases, the quantity demanded also increases. Conclusively, normal goods have a positive income elasticity of demand
2. For inferior goods, the Engel curve has a negative gradient. That means that as the consumer's income increases, fewer amounts of the inferior good are bought because they are capable of purchasing better goods. Conclusively, inferior goods have a negative income elasticity of demand.
3. For necessity goods, as the consumer's income increases, the amount demanded increases slightly and then becomes constant. Conclusively, necessity goods have zero income elasticity of demand.

REASONS WHY PEOPLE DEMAND FOR GOODS

1. **For functional reasons/ to create utility.**
   Some people buy goods to use them to satisfy their needs. A commodity is demanded because of its function or use. For example one buys a bottle of water to quench thirst.
2. **Impulsive effect.**
   This is the demand for a good after seeing it. For example as a hawker is moving around, some people may develop the idea of buying a product because they have seen it.
3. **Speculative demand/ effect.**
   Some people buy more of certain goods hoping that they might become scarce in the future. Others buy goods hoping to make gains by buying at a lower price and selling them at a higher price in the future.
4. **Snob effect/ conspicuous consumption.**
   This is the demand for a good in order to impress the public or to show off. In this case, the good is demanded highly when its price is high and vice versa. The consumption of expensive commodities in order to show off is referred to as conspicuous consumption.
5. **Veblen effect/ exclusivity.**
   This is the demand for a good in order to look unique or look different from others.
6. **Band wagon effect/ inclusivity.**
   This is the demand for a good so as to like others. Some people buy goods because they have seen others using them.
7. **For purposes of producing other goods.**
   Some people buy capital goods for use in the production of other goods.

8. **For complementary reasons.**
   Some people buy goods because they want to make other goods in their possession useful or operational e.g. one buys fuel to make a car useful.

THE THEORY OF CONSUMERS' BEHAVIOURS

A consumer is an individual who buys products or services for personal use and not for manufacture or resale.

A consumer is always faced with a problem of allocating a fixed income among a variety of available options.

A consumer is assumed to be rational i.e. given his income and the market prices of the various commodities; he plans the spending of his income so as to attain the highest possible utility.

DEFINITION OF CONCEPTS

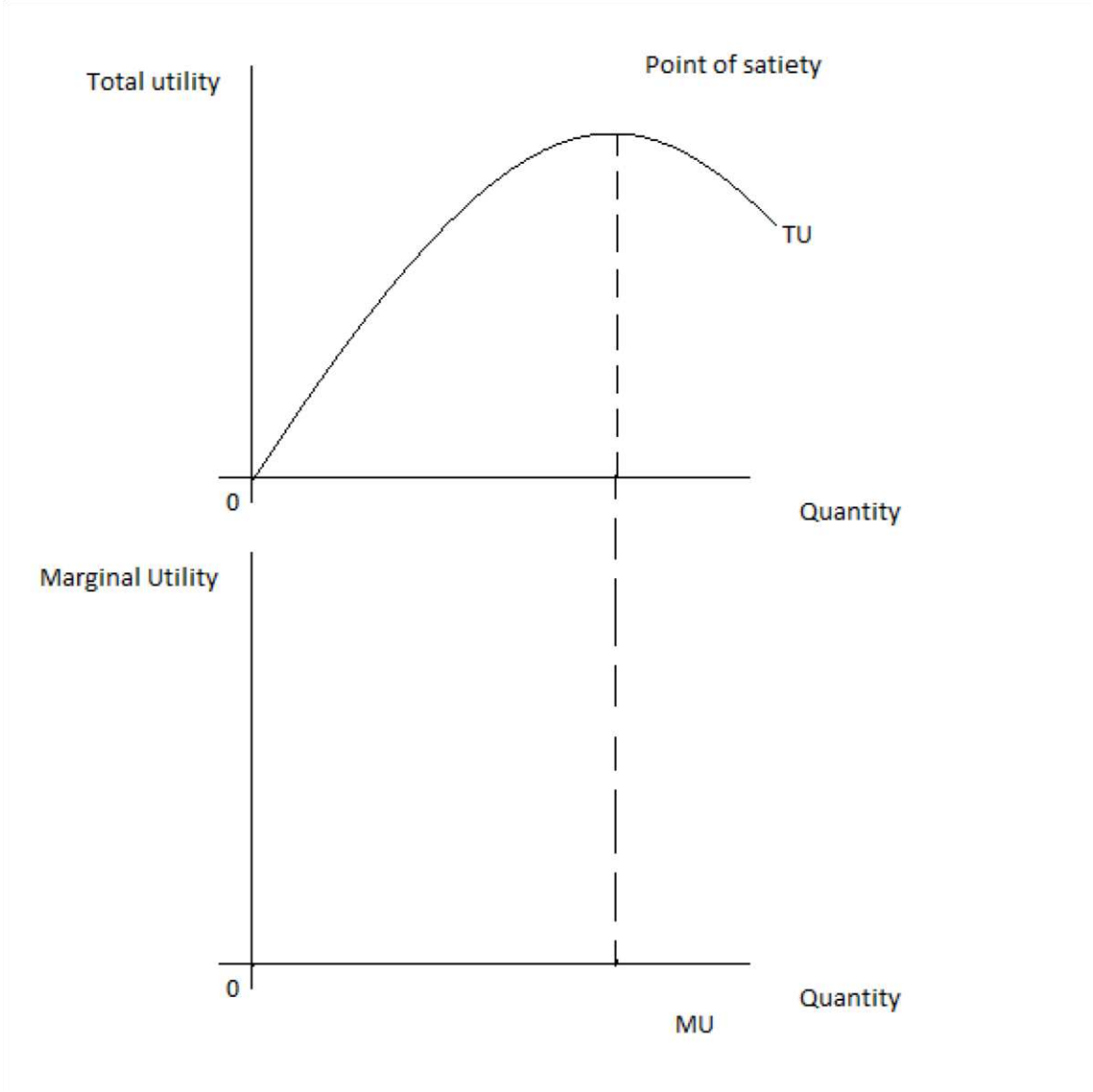
1. Utility
   This is the satisfaction derived from consuming a certain amount of a good or service.
   OR
   Utility is the ability of a commodity to give satisfaction for example water has utility because it can quench your thirst.
   Utility can be measured in monetary units by the amount of money a consumer is willing to sacrifice for a given amount of a commodity.
2. Total utility
   This refers to the total satisfaction obtained from the consumption of all possible units of a commodity.
3. Marginal utility
   This is the additional satisfaction derived from consuming an extra unit of a commodity.
   Marginal utility is calculated as follows.

$$Marginal utility = \frac{Change \in Total\ Utility}{Change \in number\ of\ units}$$

$$MU = \frac{\Delta TU}{\Delta Q}$$

The concepts of total utility and marginal utility can be better understood from the following schedule and diagram.

Units consumed	Total Utility	Marginal Utility
0	0	– ¿
1	20	20
2	37	17
3	47	10
4	52	5
5	52	0
6	47	– 5
7	35	– 12



- From the schedule and the diagram above, we note the following;
- As total utility is increasing, marginal utility is falling but positive.
- When total utility is at its maximum (point of satiety), marginal utility is zero.
- When total utility is decreasing, marginal utility becomes negative and this shows disutility.

4. Disutility

This is the loss of satisfaction due to consumption of so many units of a commodity.

THE LAW OF DIMINISHING MARGINAL UTILITY

It is states that as more and more units of a commodity are consumed in succession, the satisfaction derived from each additional unit consumed reduces.

ASSUMPTIONS UNDERLYING THE LAW OF DIMINISHING MARGINAL UTILTIY

It assumes that the consumer aims at utility maximization.

- The consumer has a fixed level of income.
- The commodity prices are fixed and constant.
- The consumer has perfect knowledge about the prevailing market conditions.
- The consumer's tastes and preferences and preferences are constant.

It assumes consumption of only one commodity whose units are homogeneous.

It assumes that the commodity has uniform sizes i.e. the commodity is divisible into similar portions.

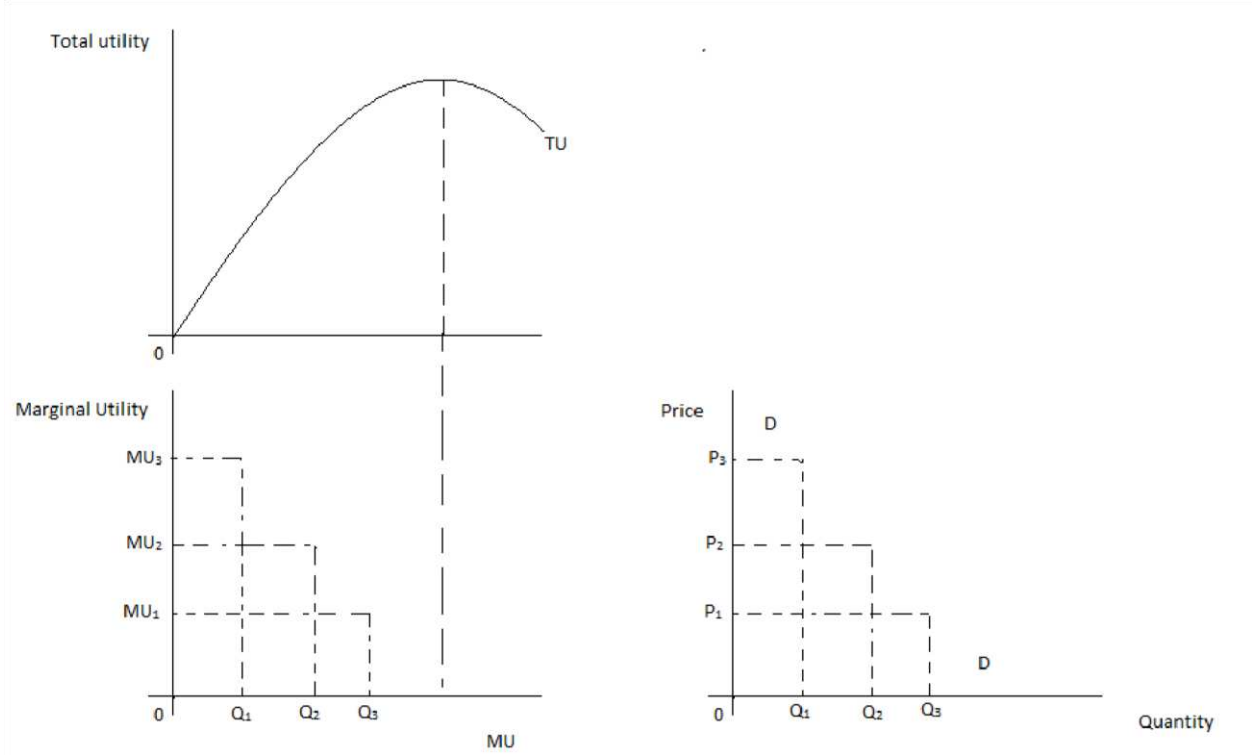
- It assumes continuity in consumption i.e. the units of the commodity should be consumed in succession one after the other.

It assumes that the consumer does not develop addiction to the commodity.

It assumes that utility is measurable in monetary units (utils).

It assumes that the commodity consumed is a normal good.

RELATIONSHIP BETWEEN MARGINAL UTILITY AND THE DEMAND CURVE



The derivation of the demand curve is based on the law diminishing marginal utility. Marginal utility is the slope of the total utility curve.

As marginal utility declines, the consumer is willing to pay less for the commodity. The consumer can buy more if the price is reduced since marginal utility is low.

When fewer units of the commodity are available, marginal utility is high and the consumer is willing to pay high prices for the commodity. This implies that demand is more at lower prices and less at high prices.

If marginal utility is measured in monetary units, then the demand curve for the commodity is identical to the positive segment of the marginal utility curve.

APPLICABILITY OF THE LAW OF DIMINISHING MARGINAL UTILITY

1. It helps to explain the law of demand.
2. It is applied under the principle of progressive taxation.
3. The law is used to explain the water – diamond paradox.
4. It explains why discounts are offered on extra units purchased.

5. Guides consumers when making consumption decisions.
6. It guides in pricing of goods and services.

LIMITATIONS/ CRICISIMS/ DEFECTS OF THE LAW OF DIMINISHING MARGINAL UTILITY

1. It assumes that consumers are rational which is not always the case. Many consumers do not attach cardinal values on commodities being consumed.
2. It assumes that the units of the commodity consumed are homogeneous which is unrealistic. Units of the same commodity may be different e.g. when consuming a sugarcane.
3. It assumes constant tastes and preferences yet for the same individual; tastes and preferences keep on changing from time to time depending on the environment, age, fashion, etc.
4. Consumption is not always continuous i.e. the consumers take breaks when consuming commodities.
5. It assumes that commodities are divisible into standard sizes but this does not apply to all commodities e.g. furniture, vehicles, etc.
6. The law is not applicable to money because the more money one gets, the more marginal utility he/she gets.
7. It is not applicable under habitual consumption where marginal utility increases as the consumer consumes more of the commodity.
8. It is not applicable in situations where the commodity prices keep on changing due to inflation.
9. The assumption that the consumer's income is fixed is unrealistic.
10. Utility cannot be measured as the law assumes i.e. there is no instrument which can be used to measure utility.
11. The law is not applicable in situations of joint demand where two commodities are consumed at the same time. This is because it assumes consumption of only one commodity at a time.
12. In most cases, the consumers are ignorant about the market prices of commodities. This violates the assumption of perfect knowledge of the consumer about the market price.

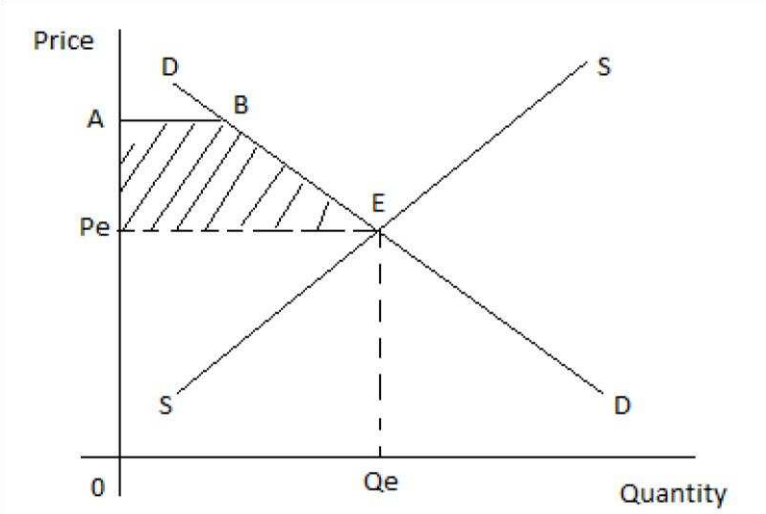
CONSUMER'S SURPLUS

This is the difference in monetary units between what the consumer is willing to pay for a commodity and what he actually pays.

OR

It is the additional utility which the consumer enjoys without paying for it.

Illustration



Consumer's surplus is represented by the shaded region (Area under the demand curve but above the equilibrium price) i.e. Area PeABE. It can be computed using the formula;

Consumer ' ssur plus=Planned expenditure−Actualexpenditu ℜ

Example

Study the table below showing the price and quantity purchased of commodity X and answer the questions that follow.

Price consumers are willing to pay (shs)	Units purchased
300	1
250	2
200	3
150	4
100	5
50	6

Calculate the consumer's surplus if 4 units of the commodity were purchased at shs 150. Solution

$$Consume\acute{r}\ ssurplus = Planned\ expenditure - Actual expenditure$$

¿ $shs((300+250+200+150)-(150\times 4))$ ¿

$shs(900-600)$

¿ $shs300$

ALT

$$Consumer\acute{}\ ssurplus = Planned\ expenditure - Actual expenditure$$

$300-150=150$ $250-150=100$

$200-150=50$

$150-150=0$

¿ $shs300$

Exercise

a) What is consumer's surplus? (01 mark) b) Given the table below;

Price consumers are willing to pay (shs)	Units purchased
9,000	1
8,000	2
7,000	3
6,000	4
5,000	5
4,000	6
3,000	7
2,000	8

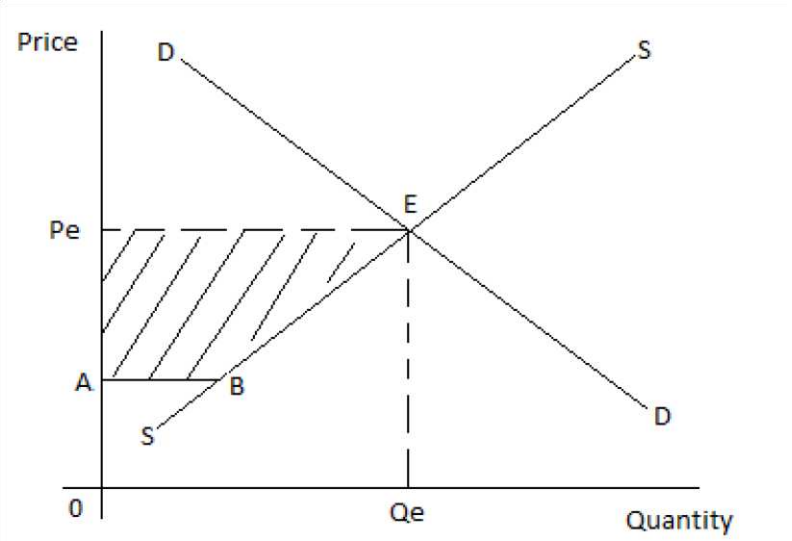
Calculate the consumer's surplus for the first five units of the commodity purchased.

(03 marks)

PRODUCER'S SURPLUS

This is the difference between the actual revenue a seller gets and the revenue he expected.

Illustration



The producer's surplus is represented by the shaded area (Area above the supply curve but below the equilibrium price) i.e. Area. APeEB.

It can be computed using the formula;

Produce r' surplus=Actualrevenue−Expected revenue

Example

Given the supply schedule below;

Price(shs) 50 60 80	100 140 200	Quantity supplied 1	2 3 4 5 6

Taking 100 to be the equilibrium price, calculate the producer's surplus.

Solution

Produce r' surplus=Actualrevenue−Expected revenue

¿ *shs*¿

¿ *shs*(400−290)

¿ *shs*110

Exercise

a) Distinguish between producer's surplus and consumer's surplus. (02 marks)

b) Given that the market price of the commodity is Uganda shs 65,000; calculate the producer's surplus in the table below.

Price (Ugx)	30,000	35,000	40,000	45,000	50,000	55,000	60,000	65,000
Supply	1	2	3	4	5	6	7	8

(02 marks)

SUPPLY THEORY

Supply refers to the quantity of goods and services that sellers are willing to put on the market at a given price in a given period of time.

TYPES OF SUPPLY

1. **Complementary (Joint) supply.**

Joint supply refers to the supply of two or more commodities from the same process of production/ same source/ same resources such that an increase in the supply of one commodity leads to increase in the supply of the other.

Examples of joint supply include;

- Supply of meat and skin from slaughtered animals/ beef and hides from slaughtered animals
- Supply of petrol, diesel and paraffin from crude oil (through factional distillation)

- Supply of mutton and wool
- Supply of maize flour and maize bran

2. **Competitive supply**

This refers to the supply of two or more commodities that use the same resources for their production such that an increase in the supply of one product leads to decline in the supply/ production of the other. Examples of competitive supply include;

- Supply of eggs and meat from chicken
- Supply of milk and meat from cows
- Crop and animal production from a piece of land.
- Supply of jerry cans and basins from plastics.

FACTORS THAT INFLUNCE/ DETERMINE / AFFECT THE QUANTITY OF A COMMODITY SUPPLIED

1. **Price of the commodity.**

A high price for the commodity in question leads to high supply because it attracts many producers to produce and maximize profits. However, a low price leads to low amount supplied because it discourages some producers from engaging in production.

2. **The cost of production.**

At a high cost, the supply is low because the producer is only able to mobilize few factors of production or few raw materials. However at a low cost of production, supply is high because the producer is able to acquire many factors of production.

3. **The number of firms in the industry.**

A large number of producers for a given commodity leads to high supply because the producers are jointly able to produce a lot of output. However, a small number of producers leads to limited competition in production leading to low output and low supply.

4. **The level of demand for the commodity/ market size.**

High demand for a product leads to high supply because it encourages production and therefore leads to high output produced.However, low demand leads to low supply of the commodity because it discourages production and therefore leads to low output produced.

5. **Level of technology used in the production of the commodity.**

The use of efficient and modern technology leads to high supply since such technology improves the speed at which goods and services are produced. However, poor methods of production lead to low supply since the production process is made slow.

6. **Length of gestation period.**

The longer the gestation period, the longer it takes the producer to make a good hence leading to low supply. However, a short gestation period creates high supply because the producer is able to produce a lot of output in a limited period of time.

7. **The objective of the firm.**

A producer whose main objective is to maximize sales produces high output leading to high supply. However, a producer whose main objective is to maximize profits limits output in order to charge a high price hence leading to low supply.

8. **The level of supply of factor inputs/ availability of factors of production.**

Availability of factors of production encourages production leading to high output and high supply. However, scarcity of factors of production discourages production leading to low output and low supply.

9. **The price of a jointly supplied commodity.**

A high price for the jointly supplied good like beef cause high supply for the commodity in question like hides. However a low price for the jointly supplied good for example beef leads to low supply for the commodity in question like hides.

10. **The price of a competitively supplied product.**

A high price for competitively supplied good like eggs causes low supply for the commodity in question like meat from chicken. However, a low price for the competitively supplied good for example eggs leads to high supply for the commodity in question like meat from chicken.

11. Political climate in the area.

During periods of political stability, supply is high because production is encouraged. However political instability scares away producers and sometimes put production to a standstill leading to low output and low supply.

12. Natural factors/ climatic conditions.

This is especially with respect to agricultural products. Favourable climatic conditions like reliable rainfall lead to high agricultural production leading to high supply. However, unfavourable climatic conditions like long droughts lead to low agricultural production leading to low supply.

13. Level of development of infrastructures.

Availability of adequate and well developed means of transport and communication facilities makes it possible to move commodities from one place to another hence high supply. However, under developed infrastructures lead to low supply because they make transportation of raw materials to production centres and finished goods to market centres difficult.

14. Degree of freedom of entry of firms into the industry.

Free entry of new firms into the industry leads to high supply because of the high competition resulting in production of a lot of output. However, restricted entry of firms tends to limit competition in production leading to low output and low supply.

15. Government policy of taxation and subsidization.

A favourable government policy for example in form of more production subsidies and low taxes to producers promotes production leading to high supply. However, unfavourable government policy in form of low subsidies and high taxes to producers discourages producers leading to low supply.

16. Working conditions.

Favourable working conditions encourage production hence high supply. However, poor working conditions discourage production leading to low supply.

17. Expectation of future price changes.

If the producers expect the prices to increase in future, current supply is low because they store the goods so as to sell them in the future at high prices and make a lot of profits. However, if the producers expect a fall in prices, current supply is high because they want dispose of the commodities before prices fall to avoid making losses.

THE LAW OF SUPPLY

The law of supply states that the higher the price, the higher the quantity supplied and the lower the price, the lower the quantity supplied ceteris paribus.

THE SUPPLY SCHEDULE

This is a table showing the number of units of a commodity sellers are willing to offer at alternative prices during a given period of time all other things being equal.

ILLUSTRATION

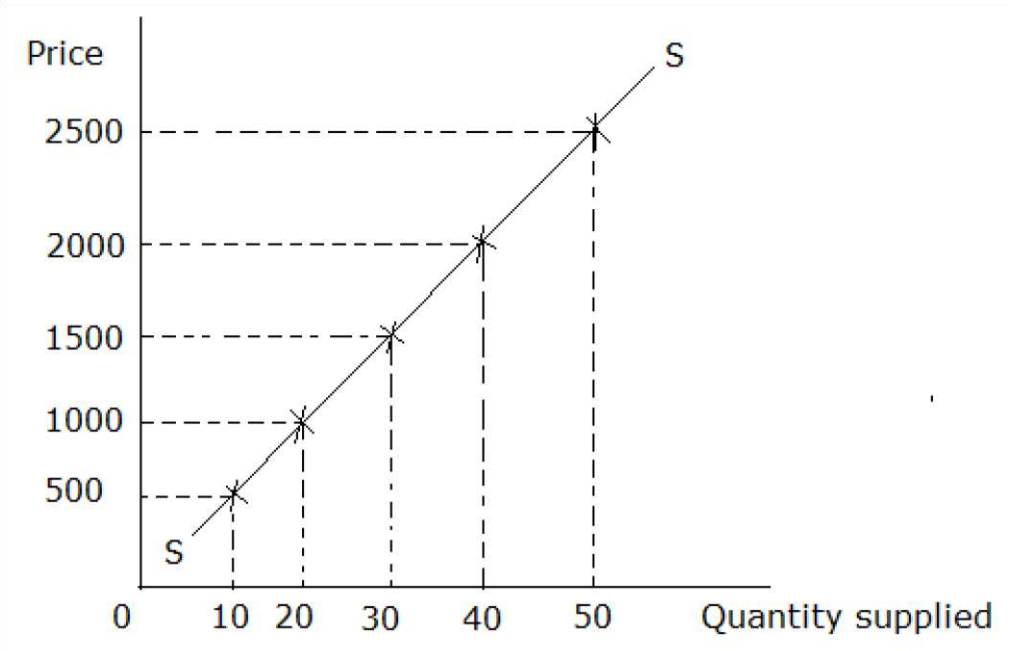
Price in shillings	Quantity supplied in kg
500	10
1000	20
1500	30
2000	40
2500	50

From the table above, it can be seen that as the price increases, quantity supplied also increases.

THE SUPPLY CURVE

The supply curve is the graphical representation of the supply schedule.

The supply curve is a locus of points showing the quantities supplied of a commodity at various prices in a given period of time.
From the above table, we derive the supply curve by plotting price against quantity supplied as shown below.



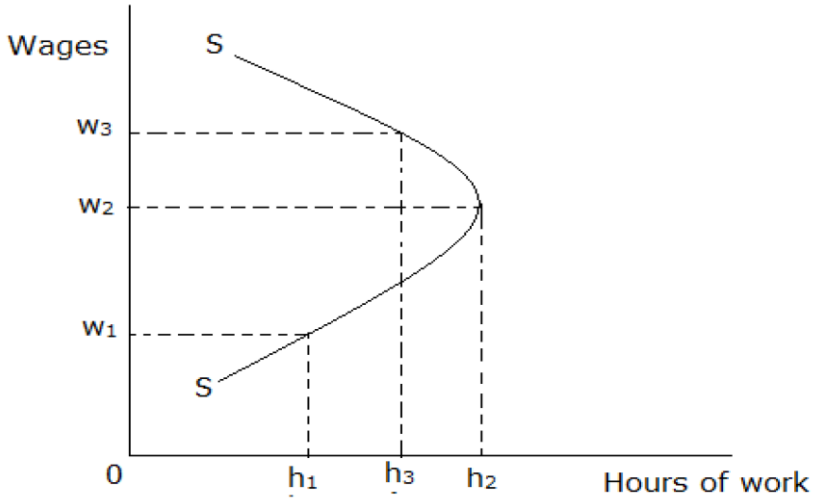
A normal supply curve is upward sloping from left to right, that is it has a positive slope meaning that there is a direct relationship between price and quantity supplied. (As price increases, quantity supplied increases and vice versa).

ABNORMAL/ REGRESSIVE/ EXCEPTIONAL SUPPLY CURVES

These are curves which do not obey the law of supply which states that the higher the price, the higher quantity supplied and the lower the price, the lower the quantity supplied ceteris paribus.
The following are the factors that violet the law of supply.

1. Supply of labour.

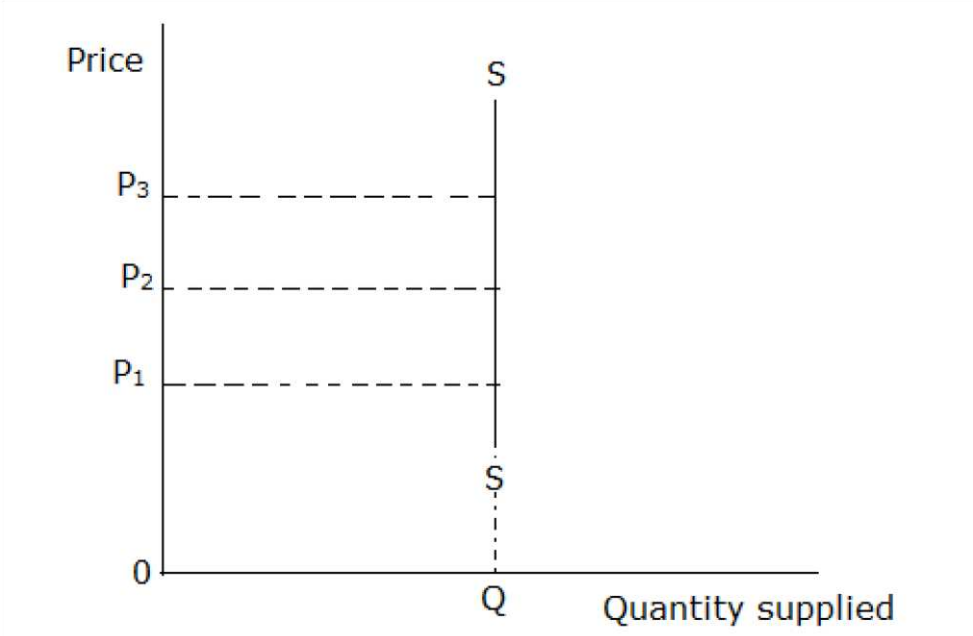
The supply curve for labour is as shown below.



From the curve, when the wage increases from OW_1 to OW_2, labour supply increases from Oh_1 to Oh_2. Further increase in wages from OW_2 to OW_3 leads to a reduction in labour supply from Oh_2 to Oh_3. This is due to the following factors;

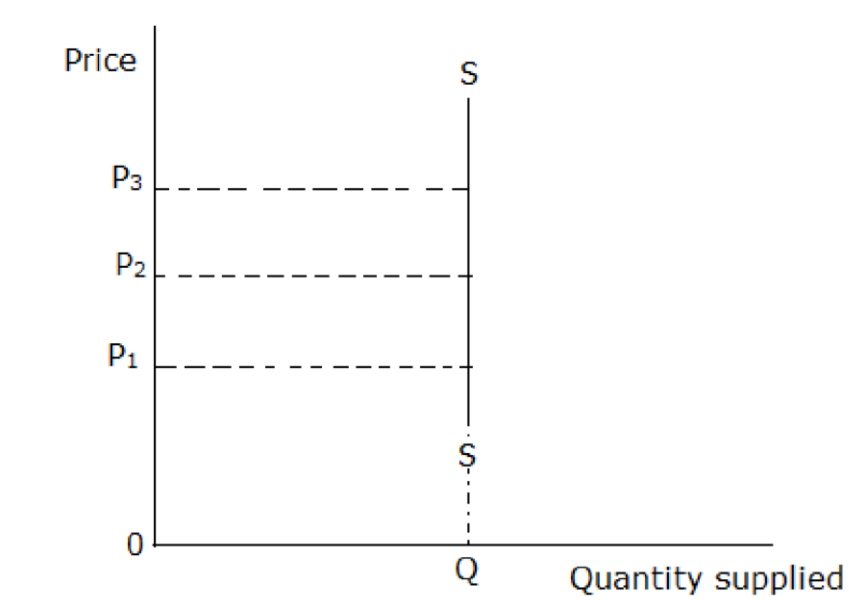
- Presence of target workers
- Preference of leisure to work
- Existence of a progressive tax system/ increased rate of taxation
- Cultural and political factors which influence reduction in labour supply (Discrimination in the employment sector)
- Declining working conditions
- Effect of old age
- Decline in the real wage of workers due to high levels of inflation

2. **Supply rigidities.**
   At times the producers may not supply more even if the price of the commodity increases due to supply rigidities such as drought, political instabilities, etc. this causes a fixed supply.



From the diagram above, same quantity is supplied at different prices until when the supply rigidities are removed.

3. **Supply of land.**
   The supply of land cannot be increased. It is a fixed resource.



From the diagram, supply remains constant in spite of price changes.

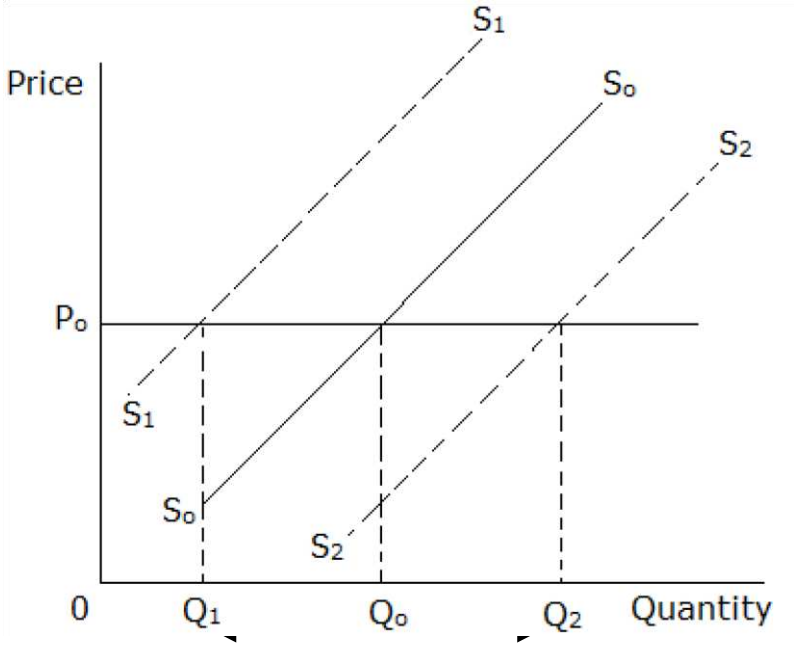
4. **Expectation of future price changes (speculation)**
   If producers expect the prices to increase in future, they put less on the market even if prices are slightly increasing. This is because they expect to get a lot of profits in future by selling at high prices. On the other hand, if the prices are expected to fall in the future, producers supply more even if the prices are slightly decreasing. This causes an abnormal supply curve.
5. **Supply of perishable goods**
   For perishable goods, more is supplied immediately after harvest whether prices are high or low hence violating the law of supply.
6. **Exhaustion of raw materials.**
   In this case, even if there is an increase in price, quantity supplied may not increase because the producers have no requirements to produce final goods.
7. **Existence of commodities supplied by the government.**
   The government may decide to supply certain essential commodities to consumers at lower prices to improve peoples' standards of living. This creates a regressive supply curve.

CHANGE IN SUPPLY AND CHANGE IN QUANTITY SUPPLIED

CHANGE IN SUPPLY

A change in supply is where more or less units of a commodity are supplied due to changes in other factors that determine supply keeping price of the commodity constant.
It is illustrated by the total shift of the supply curve either inwards to the left of outwards to the right at a constant price.

Illustration



From the diagram above, SoSo is the original supply curve.
S_1S_1shows a shift of the supply curve inwards from SoSo representing a decrease in supply
S_2S_2shows a shift of the supply curve outwards from SoSo representing an increase in supply.

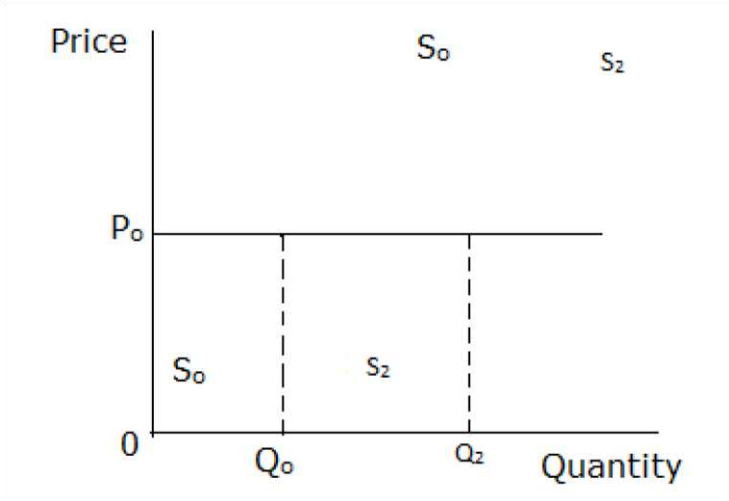
FACTORS THAT CAUSE A CHANGE IN SUPPLY OF A COMMODITY

1. Change in the cost of production.
2. Change in the number of firms in the industry.
3. Change in the level of demand for the commodity/ market size.
4. Change in the level of technology used in the production of the commodity.
5. Change in the objective of the firm.
6. Change in the gestation period of the commodity
7. Change in the level of supply of factor inputs/ availability of factors of production.
8. Change in the price of a jointly supplied commodity.
9. Change in the price of a competitively supplied product.
10. Change in the political climate in the area.
11. Change in natural factors/ climatic conditions.
12. Change in the level of development of infrastructures.
13. Change in the degree of freedom of entry of firms into the industry.
14. Change in government policy of taxation and subsidization.
15. Change in working conditions.
16. Expectation of future price changes.

INCREASE IN SUPPLY

This is an economic situation where more units of a commodity are supplied at a constant price due to other factors affecting supply of that particular commodity becoming (more) favourable.

Illustration



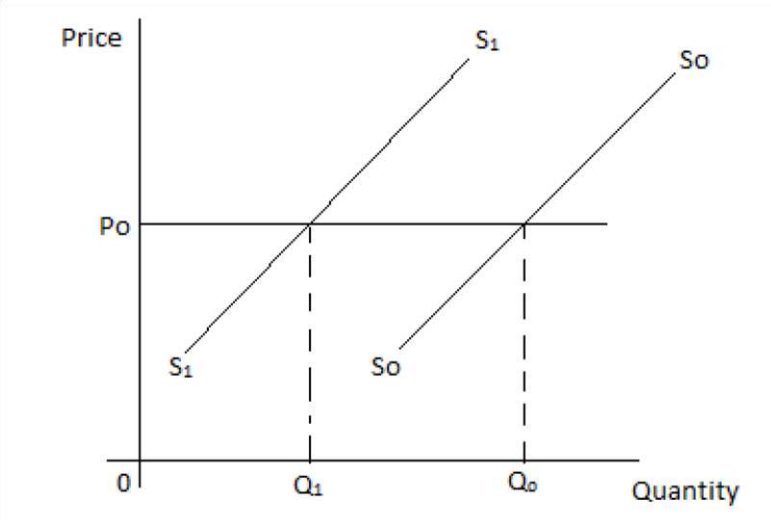
CAUSES OF AN INCREASE IN SUPPLY

1. Decrease in the cost of production.
2. Increase in the number of firms in the industry.
3. Increase in the level of demand for the commodity/ market size.
4. Improvement in technology used in the production of the commodity/ shift from inferior/ poor/ labour intensive technology to capital intensive/ superior technology.
5. Change in the objective of the firm from profit maximization to sales maximization 6. Reduction in the gestation period of the commodity
7. Increase in the level of supply of factor inputs/ availability of factors of production.
8. A fall in the price of a jointly supplied commodity.
9. Increase in the price of a competitively supplied product.
10. Political climate in the area becoming favourable 11. Natural factors/ climatic conditions becoming favourable
12. An improvement in infrastructures.
13. Increased freedom of entry of firmsinto the industry.
14. Government policy on production of a commodity becoming favourable.
15. Working conditions becoming favourable.
16. Expectation of future price fall

DECREASE IN SUPPLY

This is an economic situation where less units of a commodity are supplied at a constant price due to other factors affecting supply of that particular commodity becoming unfavourable.

Illustration



ASSIGNMENT

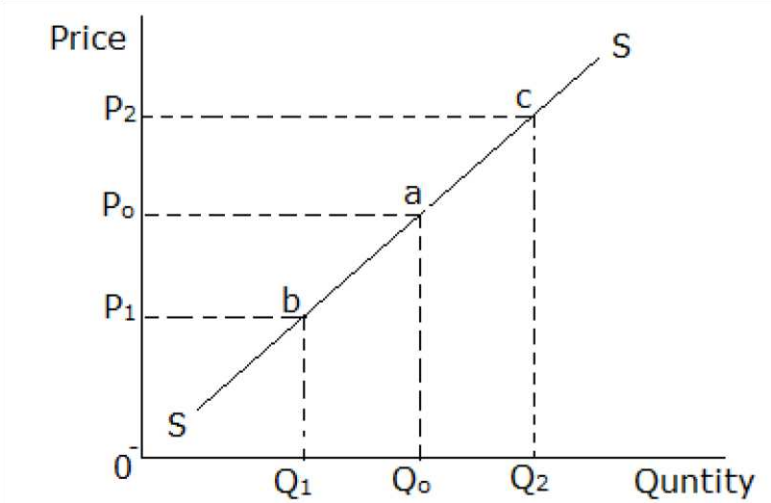
Account for a decrease in commodity supply in an economy (20 marks)

CHANGE IN QUANITY SUPPLIED

This is an economic situation where more or less units of a commodity are supplied due to changes in the price of the commodity keeping other factors determining supply constant.

it is illustrated by movement along the supply curve either upward due to price increase or downward due to price fall.

Illustration



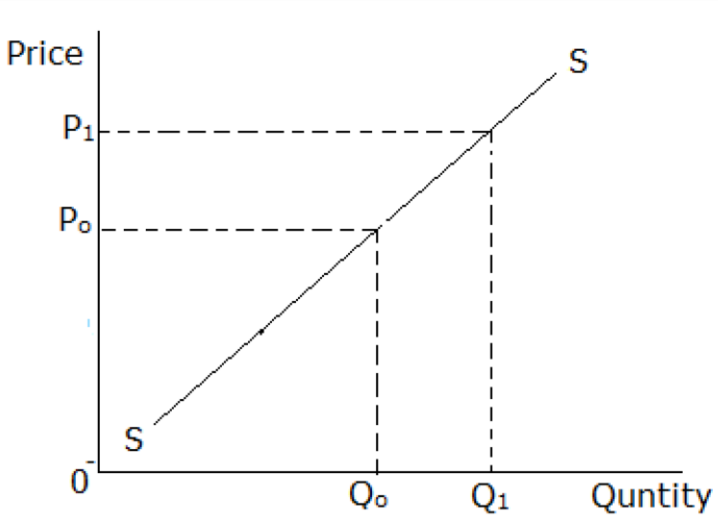
A fall in the price from OPo to OP_1leads to a decrease in the quantity supplied from OQo to OQ_1as illustrated by the movement along the supply curve from point a to b and this is known as a contraction in supply.

A rise in the price from OPo to OP_2leads to an increase in quantity supplied from OQo to OQ_2as illustrated by the movement along the supply curve from point a to c and this is known as an expansion in supply.

INCREASE IN QUANTITY SUPPLIED

This is an economic situation where more units of a commodity are supplied due to an increase in its price when other factors that affect supply of that particular commodity have not changed.

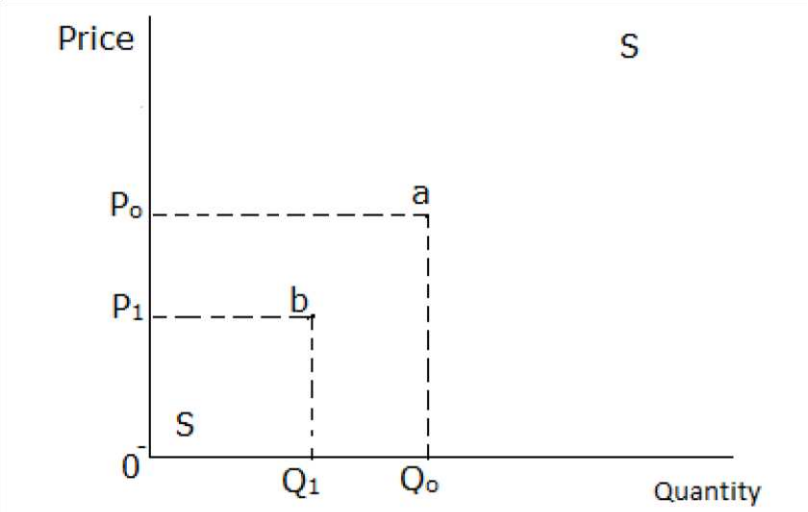
Illustration



DECREASE IN QUANTITY SUPPLIED

This is an economic situation where less units of a commodity are supplied due to a decrease in its price when other factors that affect supply of that particular commodity have not changed.

Illustration



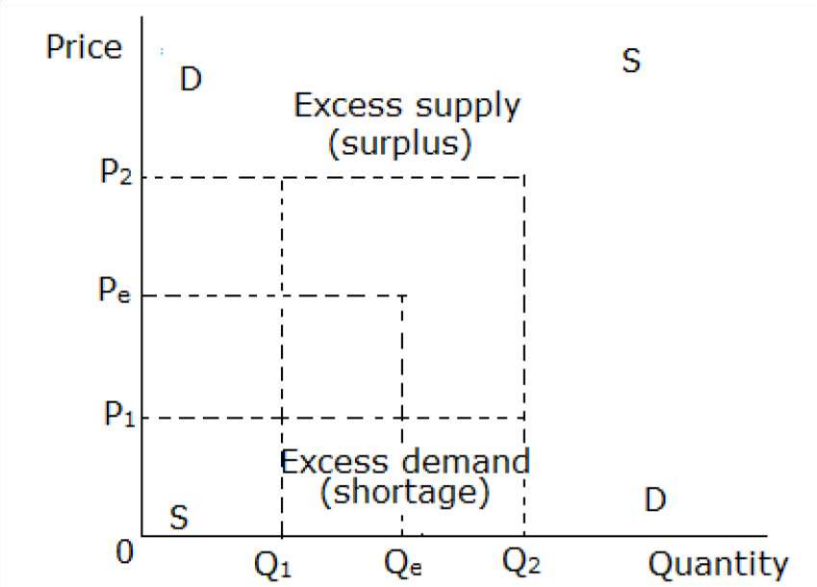
RELATIONSHIP BETWEEEN DEMAND AND SUPPLY

By the term relationship, we refer to the interaction between demand and supply. The interaction between demand and supply gives rise to the equilibrium concept.

The term equilibrium refers to a state of stability when the economic forces as they exist a particular time have no tendency to change the state of variables under consideration.

ILLUSTRATION OF THE EQUILIBRIUM CONCEPT

(THE MARKET EQUILIBRIUM)



Where E = equilibrium point
Pe = Equilibrium price
Qe = Equilibrium quantity
At a price P_2 above the equilibrium (Pe), supply exceeds demand and therefore a surplus of Q_1Q_2created. The effect is that producers decrease the price in order to sell the surplus and in the process, equilibrium is restored in the market at point E.
At a price P_1below the equilibrium (Pe), quantity demanded exceeds quantity supplied hence a shortage $Q_1Q_2$is created. This forces the producer/ seller to increase the price and again the equilibrium is restored at point E.
The price where the amount consumers want to buy equals the amount producers are prepared to sell is the equilibrium market price.

NOTE

1. Stable equilibrium is a situation whereby divergence from the equilibrium point can be restored through variation of the market forces
2. Unstable equilibrium is a situation whereby divergence form the equilibrium point can never be restored through variation of the market forces.

THE CONCEPT OF ELASTICITY

Elasticity refers to the degree of responsiveness of the dependent variable to a change in the independent variable.
The independent variable may be quantity demanded or quantity supplied while the independent variables are the factors which influence the above dependent variables.
Elasticity is categorized into two;

1. Elasticity of demand 2. Elasticity of supply.

ELASTICITY OF DEMAND

Is the measure of the degree of responsiveness of quantity demanded of a commodity to change(s) in any of the factors influencing demand like price of the commodity in question, income of the consumers, and prices of other goods.

OR

Is the ratio of change in demand of a commodity to change in the factors that affect demand.
There are as many types of elasticity of demand as the determinants of demand. However, the most important types of elasticity of demand are; 1. Price elasticity of demand (P.E.D)

2. Income elasticity of demand (Y.E.D)
3. Cross elasticity of demand (C.E.D)

PRICE ELASTICITY OF DEMAND

Refers to the measure of the degree of responsiveness of quantity demanded of a commodity to change in the price of that particular commodity

OR

P.E.D is the percentage (proportionate) change in the quantity demanded of a commodity due to a percentage (proportionate) change in the price of the commodity.

P.E. D=¿

NB

The negative is multiplied in the formula because of the negative relationship between quantity demanded and the price of the commodity.

Let Q_o = original quantity

Q_1= new quantity

P_o = original price

P_1= new price

$\Delta Q = (Q_1 - Qo) \rightarrow$ change in quantity

$\Delta P = (P_1 - Po) \rightarrow$ change in price

$$Percentage change \in quantity\ demanded = \frac{Change \in quantity}{Original quantity} \times 100$$

$$¿ \frac{\Delta Q}{Qo} \times 100$$

$$Percentage change \in price = \frac{Change \in price}{Original\ price} \times 100$$

$$¿ \frac{\Delta P}{Po} \times 100$$

$$P.E.D = ¿$$

¿¿

$$P.E.D = (-) \frac{\Delta Q}{\Delta P} \bullet \frac{Po}{Qo}$$

Worked examples

1. Given that the price of the commodity decreased from Shs 500 to Shs 400 and as a result, the quantity demanded increased from 10kg to 20kg. Calculate the price elasticity of demand. Solution
   Given that;
   Po = shs 500
   P_1 = shs 400
   Qo = shs 10 kg
   Q_1 = 20kg
   P.E. D=¿
   ¿¿
   ¿5
2. Assuming that the price of the commodity rises from Shs 1500 to Shs 2000 per kg and as a result the quantity demanded falls from 20kg to 15kg. Calculate the price elasticity of demand. Solution
   Given that;

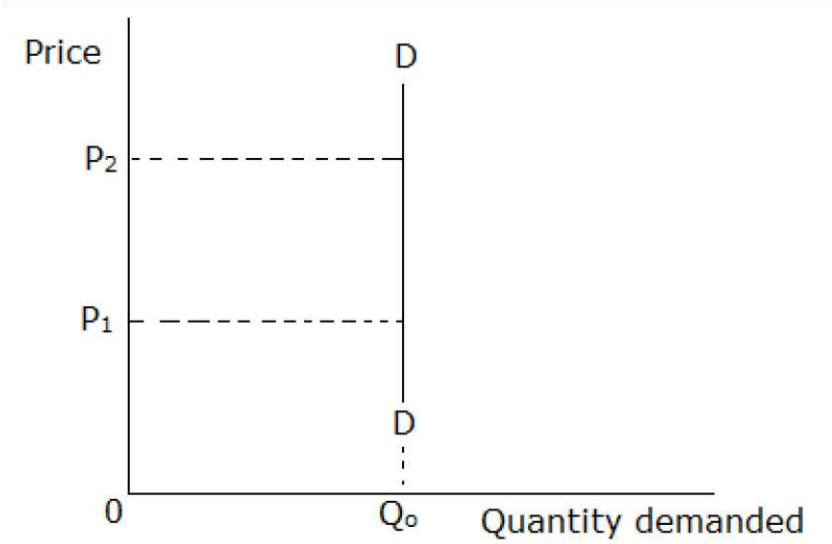
Po = shs 1500
P_1 = shs 2000
Qo = 20 kg
Q_1 = 15 kg
P.E. D=¿
¿¿
¿0.75
Trial question
The price of a given commodity decreased from Shs 10,000 to Shs 9000 and as a result, quantity demanded increased by 25%. Calculate the price elasticity of demand.

INTERPRETATION OF PRICE ELASITICITY OF DEMAND

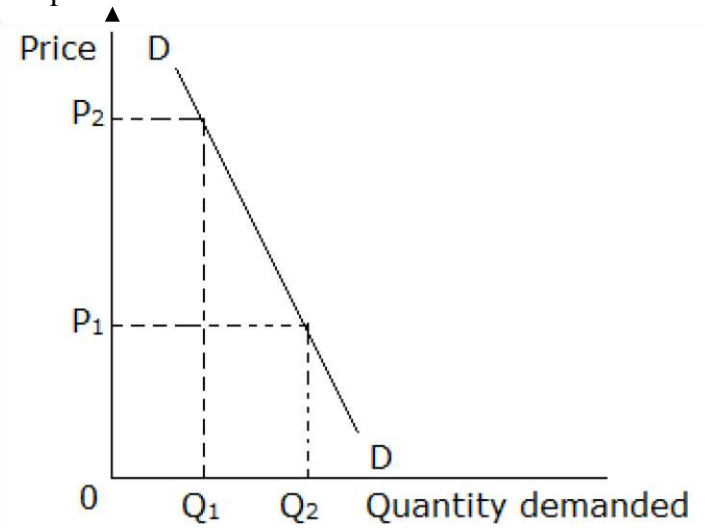
Price elasticity of demand ranges from zero to infinity ($0 \leq$ P.E.D $\leq \infty$)

1. **Perfectly inelastic demand (P.E.D = 0)**
   This is where a change in price does not affect the quantity demanded of the commodity. It is common with necessities. The demand curve is vertical.

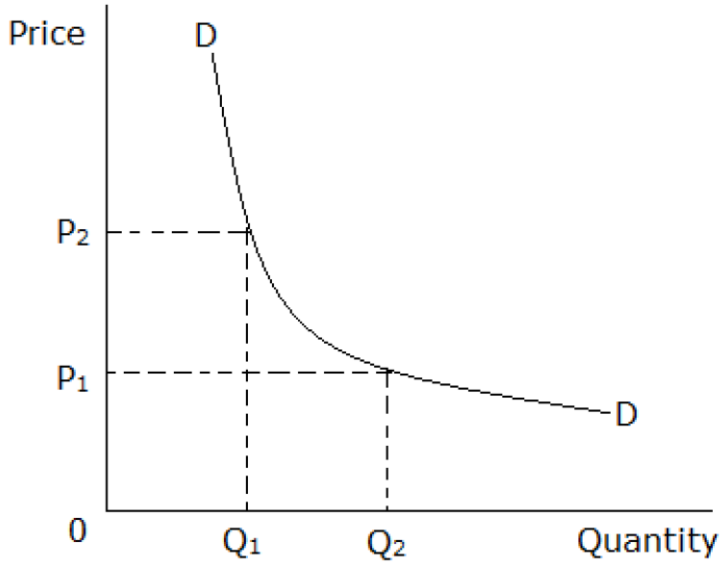
Illustration



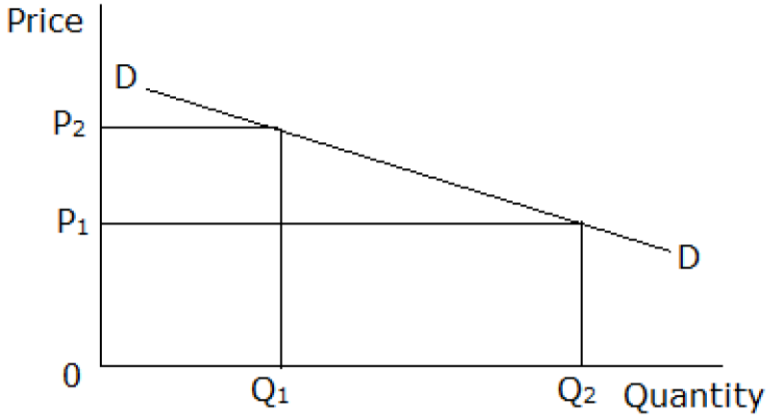
2. **Inelastic demand (Low elasticity of demand) (0 < P.E.D < 1)**
   This is where a big change in price results into a small change in quantity demanded. The slope of the demand curve is very steep.



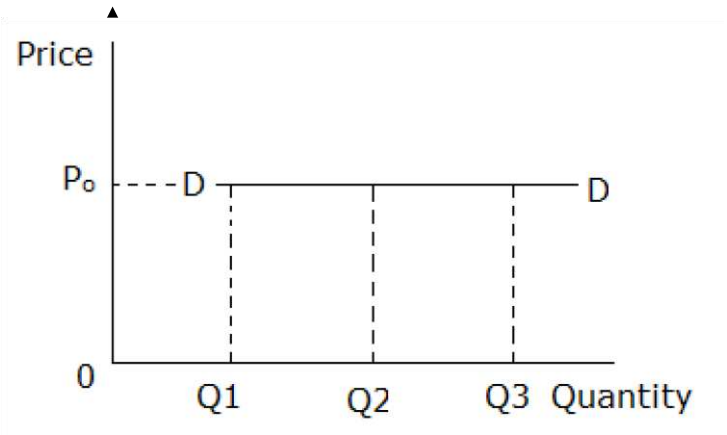
3. **<u>Unit/ unitary elasticity of demand</u> (P.E.D = 1)**
   This is where a change in price results into an equal change in quantity demanded. The percentage change in price is equal to the percentage change in quantity demanded. It is illustrated by a rectangular hyperbola.



4. **<u>Elastic demand(High elasticity of demand)</u> (1 < P.E.D < ∞)**
   This is where a small change in price results into a big change in quantity demanded. The demand curve is gently sloped.



5. **<u>Perfectly elastic demand</u> (P.E.D = ∞)**
   This is where different quantities of a commodity are demanded at a constant price. This means that the commodity has got perfect substitutes and therefore a seller cannot increase the price. The demand curve is horizontal.



EXERCISE

A change in price of a commodity from15/= to 5/= led to an increase in quantity demanded from 2kgs to 5kgs. Calculate the price elasticity of demand and interpret your answer.

FACTORS INFLUENCING PRICE ELASTICITY OF DEMAND

1. **Availability of substitutes/ degree of substitutability of the commodity.**
   Demand for commodities that have close substitutes is price elastic because slight changes in price make consumers to buy more of the other alternatives. However, demand for commodities that have no close substitutes is price inelastic because consumers have no alternatives to resort to in case of price changes.
2. **Availability of complements.**
   Demand for a commodity which is a strong complement to what the consumer has is price inelastic. For example the demand for fuel remains inelastic despite its price increase because people already have cars. However, demand for a commodity which is not a strong complement to what the consumer has is price elastic because the consumer has a choice whether to buy or not in case of price changes.
3. **Proportion of the consumer's income spent on the commodity.**
   Demand for commodities which take a very small proportion of the consumer's income is price inelastic. E.g. an increase in the price of a razor blade may not greatly affect the quantity demanded. However, demand for commodities which take a big percentage of the consumer's income is price elastic.
4. **Level of consumer's income.**
   Rich people continue to buy even if the commodity's price increases but the poor people will always stop buying even if there is a slight increase in the price hence demand is price inelastic among the rich and price elastic among the poor.
5. **Degree of necessity of the commodity**
   Demand for necessities like soap, salt is price inelastic because consumers cannot easily do without them. However, demand for non – essential items is price elastic because consumers easily reduce the amount they buy when price increases.
6. **Level of addiction in the use of the commodity.**
   Demand for an addictive commodity like cigarettes is price inelastic because such a commodity forms a habit in the consumer and the consumer almost the same units regardless of the changes in price. However, demand for non – addictive commodities is price elastic because the consumer easily reduces the amount demanded when prices increase.
7. **Level of durability of the commodity/ level of perishability of the commodity/ nature of the commodity i.e. perishable or durable commodity.**
   Demand for durable goods such as cars, furniture tends to be price inelastic because even if the price of such a commodity falls, a consumer may not demand more of that commodity because he already has it. On the other hand, demand for perishable goods is price elastic because slight changes in price bring about big changes in amount demanded.

8. **Number of uses of the commodity.**
   Demand for goods having several uses is price elastic. E.g., if the unit of price for electricity increases, consumers use less of it for only vital purposes such as lighting. On other hand, demand for goods having a single or few uses is price inelastic because consumers continue buying the same units at all times regardless of the changes in price.
9. **Time period of consumption i.e. short run or long run.**
   In the short run, the demand for a commodity tends to be price inelastic while in the long run, the demand for the commodity is price elastic. This is because in the long run, consumers are able to learn the market conditions and look for substitutes.
10. **Possibility of postponement of consumption of the commodity.**
    The demand for commodities whose use can be postponed to a future date is price elastic because small changes in the price force the consumers to postpone consumption and this creates a big change in the quantity demanded. On the other hand the demand for commodities whose use cannot be postponed is price inelastic because even with big changes in price, the amount demanded is so low.
11. **Speculation about price changes**
    When the consumers expect the price of the commodity to fall in future, the current demand tends to be price elastic because consumers easily reduce the amount demanded when the price slightly increases. On the other hand if consumers expect a future price increase, the current demand for the commodity tends to be price inelastic because consumers continue buying even if prices are rising due to fear of purchasing at very high prices in the future.
12. **Level of awareness of availability of cheaper goods/ level of advertisement.**
    Demand for highly advertised goods is price inelastic because the persuasive adverts convince the buyers to continue buying the commodity regardless of the changes in price. However, demand for less advertised commodities is price elastic because of the limited awareness of the public about the commodities.
13. **Degree/ extent of convenience in acquiring/ accessing the commodity.**
    Demand for commodities that are conveniently accessible is price inelastic whereas demand for those that are difficult to access is price elastic. This is because consumers prefer buying commodities that are within their reach compared to those that are scarce.

CAUSES OF PRICE INELASTIC DEMAND

1. The commodity not being substitutable/ the commodity having no substitutes.
2. The commodity being a complement
3. Proportion of the consumer's income spent on the commodity being high
4. The commodity being a necessity
5. The consumer's income being high
6. The commodity being habit forming/ addictive
7. The commodity being durable
8. The commodity having one or few uses
9. Short run situation
10. The consumption of a commodity not being deferrable.
11. Consumers speculating a future price increase
12. The commodity being highly advertised.
13. The commodity being conveniently accessible.

ASSIGNMENT

Explain the causes of high price elasticity of demand in your country.

IMPORTANCE/ USES PRICE ELASTICITY OF DEMAND IN AN ECONOMY

The concept of price elasticity of demand is of great importance to the following people;

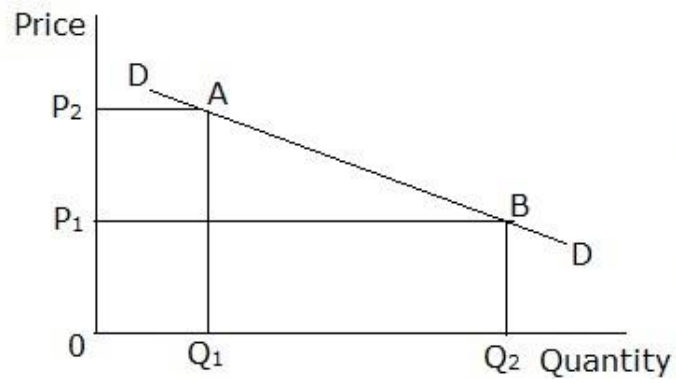
1. **Producer.**

a) Fixing prices for the commodities.

Price elasticity of demand helps the producer to fix prices for the commodity so as to maximize revenue. For commodities with elastic demand, the producer charges a lower price and for commodities with inelastic demand, the producer fixes a high price.

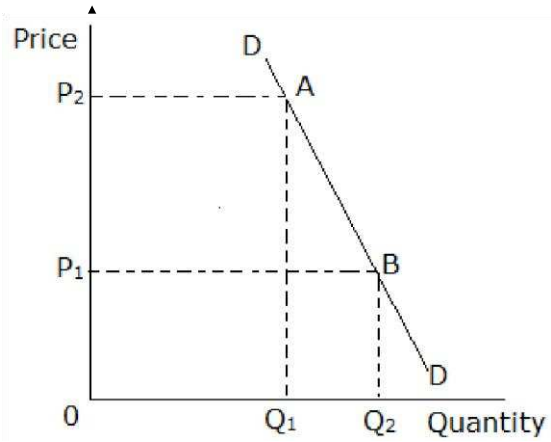
The above situation is illustrated below.

Elastic demand



For elastic demand, revenue OP_1BQ_2 is greater than revenue OP_2AQ_1.
Therefore the producer fixes a lower price OP_1 because this is when he maximises revenue.

Inelastic demand



For inelastic demand, revenue OP_2AQ_1 is greater than revenue OP_1BQ_2.
Therefore the producer fixes a high price OP_2 because this is when he maximises the revenue

NOTES

In case the price elasticity of demand for a commodity is unitary, the producer does not need to change his prices.

b) Fixing prices of commodities by discriminative monopolists.

Price discrimination is the selling of similar units of a commodity at different prices to different consumers when the differences in price are not based on the cost of production. This can only be successful if the price elasticity of demand for that commodity is different in different markets. For a market with inelastic demand, the producer charges a high price and for a market with elastic demand, the producer charges a low price.

c) Pricing of joint products.

The concept of price elasticity of demand is of much use in the pricing of joint products like wool and mutton, wheat and straw, cotton and cotton seed, meat and hides or skins, etc. In such cases, separate costs of production of each commodity are not known and therefore the price of each is fixed on the basis of its elasticity of demand. That is why products like wool, wheat, meat and cotton having an inelastic demand are priced very highly as compared to their bi-products mutton, straw, hides or skins and cotton seeds with an elastic demand.

d) Determination of the degree of advertisement for the commodity.

For commodities with elastic demand, there is need for massive advertisement so as to increase the firm's revenue. This is because increasing prices in such a case leads to a fall in revenue due to reduced quantities demanded. On the other hand, little or no advertisement is required for commodities with inelastic demand.

e) Determination of wages of a particular type of labour.

Labour producing a commodity with inelastic demand is paid a high wage. This is because the producer can recover the cost of labour by increasing the price of the commodity. However labour producing a commodity with elastic demand is a paid a low wage.

2. **Government.**

a) Used by government to determine goods to be provided as public utilities.

Government's decision to declare certain industries as public utilities depends on elasticity of demand for their products. If the demand for the product is inelastic and it is necessary to the general public, the state usually takes over the production of such products. This is because if production is left to private industries, then they will overcharge the consumers and hence the danger of monopolistic exploitation.

b) Formulation of taxation policies.

Taxes are imposed for various reasons of which we may consider these two cases.

(i) Raising revenue.

Government raises more revenue by taxing highly commodities with inelastic demand such as petroleum products. This is because these commodities are demanded irrespective of the price changes. However, low taxes should be imposed on commodities with elastic demand.

(ii) Discouraging the production and consumption of undesirable commodities

If the government wants to discourage the production and consumption of a product, it may impose a tax. The extent to which the taxation policy succeeds depends on the price elasticity of demand for the commodity. The government will be successful with commodities that have got elastic demand.

c) Devaluation of currency (exchange rate manipulation)

The main objective of devaluation is to improve the country's balance of payments position. Devaluation makes imports expensive thereby reducing their importation and exports cheaper thereby encouraging and increasing their volume. However, this is only successful when the demand for both imports and exports is price elastic.

NB:

Devaluation refers to the legal/ofcial reduction in the value of the country's currency in relation to other currencies.

d) It guides in subsidization.

Usually, subsidy or protection is given to only those industries whose products have elastic demand. This is because they are unable to face foreign competition unless their prices are reduced through subsidy or by increasing the prices of imported goods by imposing heavy duties on them. **e) Price legislation**

This is where the government fixes the price at which the commodity is to be sold to the consumers. If the commodity has inelastic demand, the government fixes a maximum price so as to protect consumers from being exploited by profit motivated producers. For commodities with elastic demand, the government fixes a minimum price in order to protect producers from being exploited by consumers.

f) Wage determination

Labour with inelastic demand is paid higher rates than labour with inelastic demand.

g) Used in making of foreign trade policies.

The concept of elasticity of demand has great practical importance in analyzing some of the complex problems of international trade such as terms of trade, gains from international trade, BOP disequilibria and the effects of import tax. For instance tariff barriers (taxes) are more effective in controlling the importation of goods whose demand is price elastic. This is because tariff barriers increase price and

this forces many people to reduce the importation/ consumption of such goods. However, non – tariff barriers like total ban, quotas are more effective in controlling importation of goods whose demand is price inelastic.

h) Determines the incidence of the tax.

Incidence of a tax refers to the final resting place of a tax and it falls on either the producer or the consumer or a combination of the two depending on the price elasticity of demand. If the demand is price inelastic, more of the tax is paid by the consumers and if the demand is elastic; more of the tax is paid by the producer. With unitary elasticity, the tax is shared equally between the consumer and producer. If the demand is perfectly elastic, the tax is fully paid by the producer alone. It is fully paid or met by the consumer alone if the demand for the product is purely or perfectly inelastic.

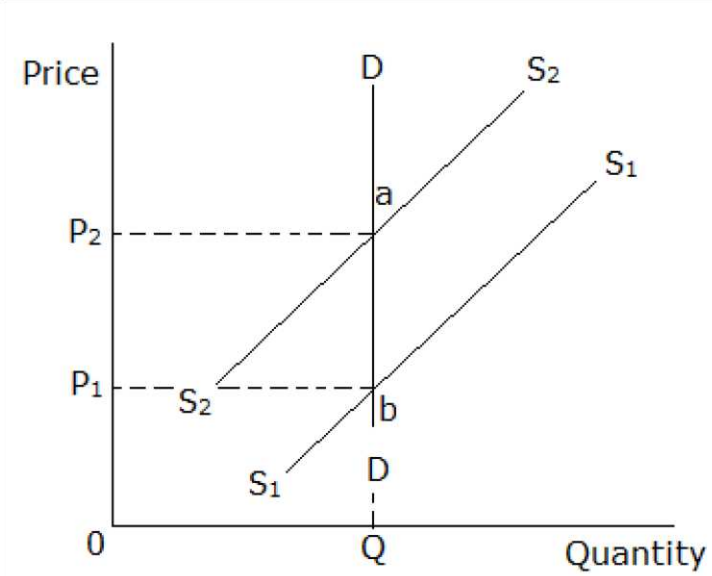
3. **Consumers.**

a) Guides consumers in planning of their expenditure.

Consumers plan to spend more on commodities whose demand is price inelastic and less on commodities whose demand is price elastic. for example they plan to spend more money on food, fuel, school fees but less money is put on luxuries like buying movies or organizing parties.

ELASTICITY AND INCIDENCE OF A TAX

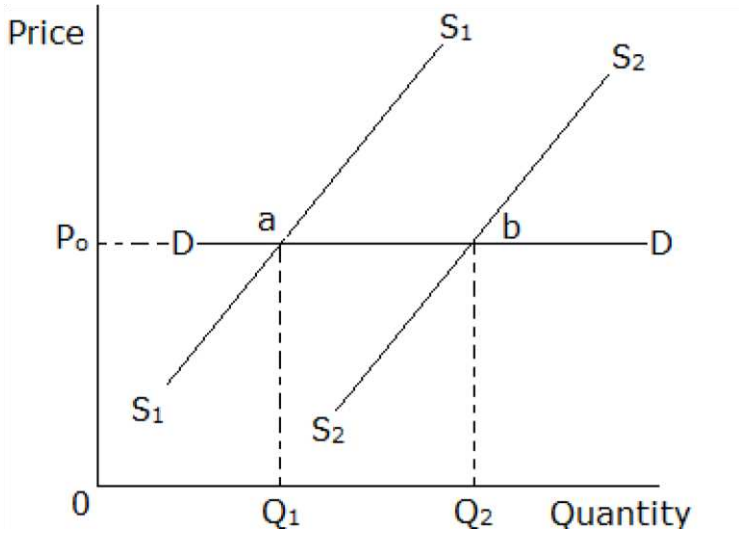
Incidence of a tax refers to the final resting place of a tax and it falls on either the producer or the consumer or a combination of the two depending on the price elasticity of demand. **Case 1: Taxation and perfectly inelastic demand**



ab = total tax paid by the consumer.

When demand is perfectly inelastic, the total tax is paid by the consumer.

Case 2:Taxation and perfectly elastic demand.

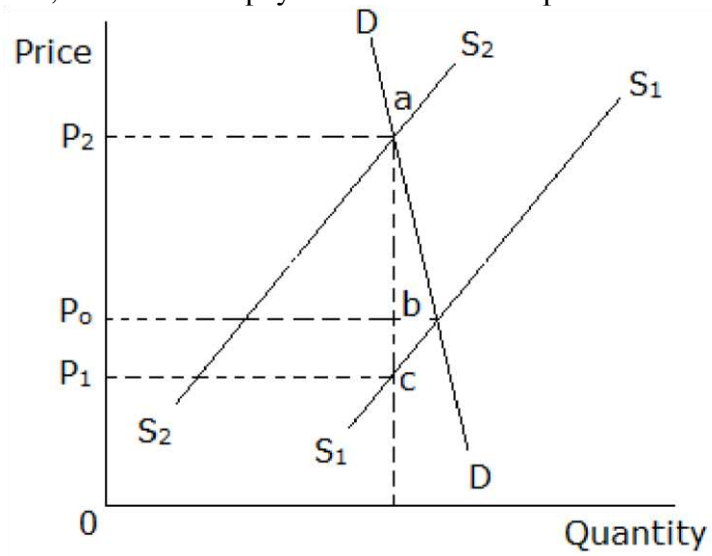


ab = total tax paid by the producer.

When demand is perfectly elastic, the total tax is paid by the producer.

Case 3: <u>Taxation and inelastic demand</u>

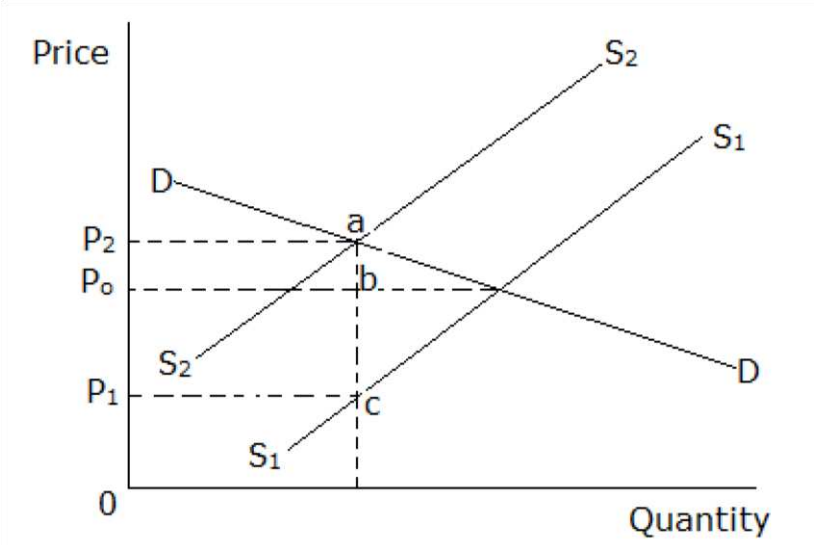
When demand is inelastic, the consumer pays more tax than the producer as illustrated below.



abc = total tax ab = tax paid
by the consumer bc = tax paid
by the producer

Case 4: <u>Taxation and elastic demand</u>

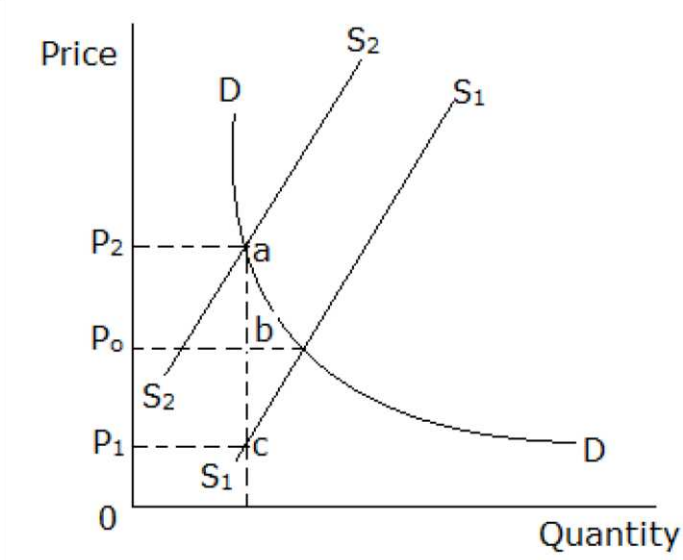
When demand is elastic, the producer pays more tax than the consumer.



abc = total tax.
ab = tax paid by the consumer
bc = tax paid by the producer

Case 5: <u>Taxation and unitary demand</u>

When demand is unitary, the tax is shared equally between the consumer and the producer.



abc = total tax ab = tax paid by the consumer bc = tax paid by the producer

<u>INCOME ELASTICITY OF DEMAND</u>

This is the measure of the degree of responsiveness of quantity demanded of a commodity to a change in consumer's income.

<u>OR</u>

It is the percentage change in the quantity demanded of a commodity due to a percentage change in the consumer's income.

Income elasticity of demand = Percentage change in quantity demanded

Percentage change in price

$$Y.E.D = \frac{\Delta Q}{\Delta Y} \bullet \frac{Y_o}{Q_o}$$

Where ΔQ = change in quantity demanded
ΔY = change in consumer's income
Q_o= original quantity demanded Y_o= original income.

INTERPRETATION OF INCOME ELASTICITY OF DEMAND

If Y.E.D is positive, the commodity is a normal good.
If Y.E.D is negative, the commodity is an inferior good.
If Y.E.D is zero, the commodity is a necessity.

Worked examples

1. Use the table below to answer the questions that follow;

Period	Income	Quantity
2007	150,000	50
2008	200,000	80

a) Calculate the income elasticity of demand.
b) State the type of the commodity in question.

Solution

a) Given that;
Yo = 150,000
Y_1 = 200,000
Qo = 50 Q_1 = 80

$$^{o}Y.E.D = \frac{\Delta Q}{\Delta Y} \times \frac{Y_O}{Q_O}$$

$$¿ \frac{80-50}{200,000-150,000} \times \frac{150,000}{50}$$

¿1.8

b) The commodity is a normal good.

2. Use the table below to answer the questions that follow.

Period	Income	Quantity
2007	150,000	50
2008	200,000	50

a) Calculate the income elasticity of demand.
b) State the type of the commodity in question.

Solution

a) Given that;
Yo = 150,000
Y_1 = 200,000
Qo = 50 Q_1 = 50

$$\frac{\Delta Q}{} \quad Y \quad ^{o}$$

$Y.E.D = \frac{\Delta Y}{} \times \frac{Q_O}{}$

$= \frac{50-50}{200{,}000-150{,}000} \times \frac{150{,}000}{50}$

$= 0$

b) The commodity is a necessity.

Trial questions

1. Given that an individual's income increased from shs 50,000 to shs 80,000 per month and this led to an increase in the demand for the commodity by 10%. Calculate the income elasticity of demand and comment on the type of the good.
2. Study the table below showing income and quantity demanded of commodity X and answer the questions that follow.

Income (Ug. Shs)	Quantity demanded of X (kg)
10,000	50
30,000	20

a) Calculate the income elasticity of demand for commodity X.

b) What type of commodity is X? Give a reason for your answer.

IMPORTANCE OF INCOME ELASTICITY OF DEMAND

1. A consumer is able to tell or predict the amount of a commodity which would be bought depending on the on the nature of the commodity. If it is an inferior good, less of it will be demanded following an increase in the consumers' income. If it is a normal good, more of it will be demanded as ones income increases and if it is a necessity, quantity demanded remains constant irrespective of changes in the consumer's income.
2. It helps in determining the type of a commodity i.e. inferior, necessity or normal good.
3. Helps the government in distribution of social utilities.
4. It helps importers in determining what to import.
5. Helps the government in policy making for example taxation.
6. Helps a seller / producer to predict future demand as income changes.

CROSS ELASTICITY OF DEMAND

This is the measure of the degree of responsiveness of quantity demanded of one commodity (X) due to a change in the price of another commodity (Y).

OR

This is the percentage (proportionate) change in quantity demanded of one commodity due a percentage change in the price of another/ related commodity.

Cross elasticity of demand = $\frac{\text{Proportionate change in quantity demanded of commodity X}}{\text{Proportionate change in the price of commodity Y}}$

$$C.E.D = \frac{\Delta Q_x}{\Delta P_y} \bullet \frac{P_y}{Q_x}$$

Where ΔQ_x= change in quantity demanded of commodity X

ΔP_y= change in the price of commodity Y

P_y= original price of commodity Y

Q_x= original quantity of commodity X

INTERPRETATION OF CROSS ELASTICITY OF DEMAND

Here we give the relationship between the two commodities.

If C.E.D is positive, the two commodities are substitutes.

If C.E.D is negative, the two commodities are complements.
If C.E.D is zero, the two commodities are unrelated/ there is no relationship between the two commodities.

Worked example

Given that the price of commodity X increased from Shs 50,000 to Shs 80,000 and this led to increase in quantity demanded for commodity Y by 10%. Calculate the cross elasticity of demand for the two commodities and state the relationship between them.

Solution

Given that;
Po = shs 5,000/=
P_1 = shs 80,000/=
Quantity demanded for commodity Y changed by 10%

$$C.E.D = \frac{\%age\ \Delta \in qnty\ demanded\ for\ commodity\ Y}{\%age\ \Delta \in the\ price\ of\ commodity\ X}$$

$$\%age\ \Delta \in price\ of\ commodity\ X = \frac{P_1 - P_o}{P_o} \times 100$$

$$¿ \frac{80,000 - 50,000}{50,000} \times 100$$

$$¿ \frac{30,000}{50,000} \times 100$$

¿60%

$$C.E.D = \frac{10\%}{60\%} = \frac{1}{6} = 0.167$$

X and Y are substitutes.

Trial questions

1. Given that an increase in the price of commodity X form Shs 1500 to Shs 1800 resulted into a change in quantity demanded for commodity Y from 600 units to 570 units;
   a) Calculate the cross elasticity of demand
   b) State the relationship between commodities X and Y.
2. If the price of commodity X falls from Ug. Shs 2,000,000 to Ug. Shs 1,600,000 per unit and the quantity demanded of commodity Y increases from 40,000 to 60,000 units,
   a) Calculate the cross elasticity of demand.
   b) State the relationship between commodities X and Y.

ELASTICITY OF SUPPLY

This is the measure of the degree of responsiveness of quantity supplied of a commodity to changes in factors which influence supply.

PRICE ELASTICITY OF SUPPLY

This is the measure of the degree of responsiveness of quantity supplied of a commodity to a change in the commodity's price.

OR

This is the percentage change in the quantity supplied of a commodity due to a percentage change in the price of the commodity.

$$Price\ elastcity\ of\ supply = \frac{Percentage change \in quantity\ supplied}{Percentage\ change \in the\ price of\ the\ commodity}$$

$$P.E.S = \frac{\Delta Q}{\Delta P} \times \frac{P_o}{Q_o}$$

Where;

ΔQ=*Change*∈*quantity supplied*
Δ *P*=*Change*∈*priceof the commodity*
P_O=*Original price*
Q_O=*Originalquantity*

Worked examples

1. The price of a commodity increased from shs 800 to shs 1200 per kg and the quantity supplied in the market increased from 2000kgs to 5000kgs. Calculate the price elasticity of supply. Solution
   Given that;
   Po = shs 800
   P_1 = shs 1200
   Qo = 2000kgs
   Q_1 = 5000kgs

$$P.E.S = \frac{\Delta Q}{\Delta P} \times \frac{P^O}{Q_O}$$

$$¿ \frac{5000-2000}{1200-800} \times \frac{800}{2000}$$

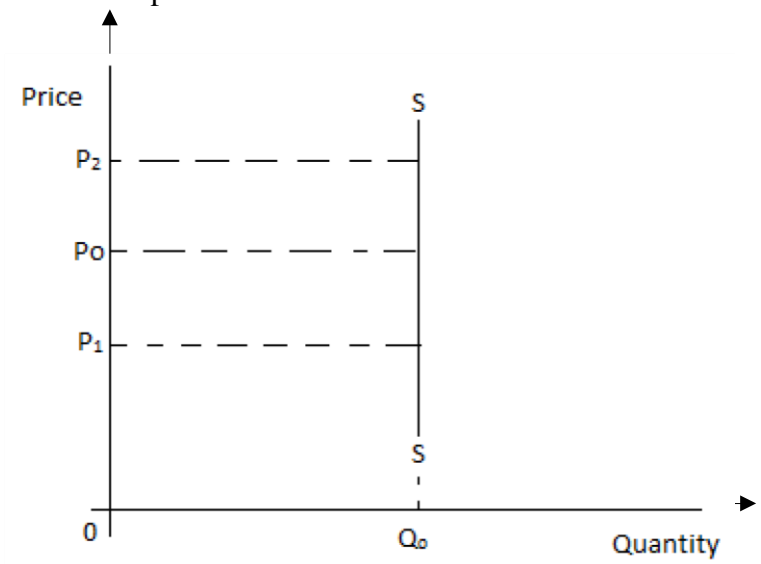
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Exercise

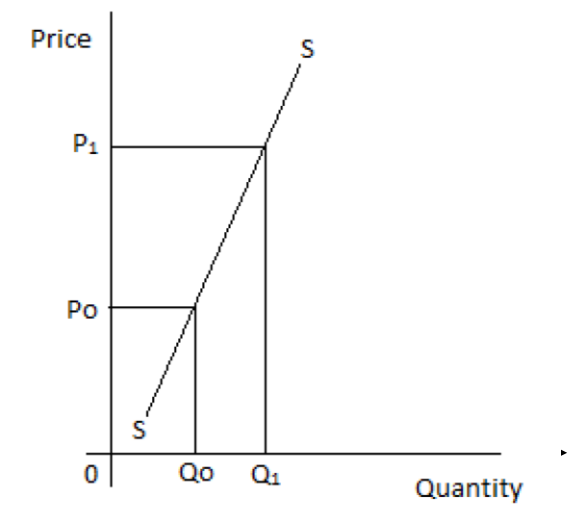
1. An increase in price from 60,000 to 90,000 led to an increase in quantity supplied of commodity by 50 %. Calculate the price elasticity of supply.
2. An increase in price from shs 40/= to 400/= led to an increase in the quantity supplied of a commodity from 30kgs to Xkgs. If the price elasticity of supply is 2, find the value of X.

INTERPRETATION OF PRICE ELASTICITY OF SUPPLY

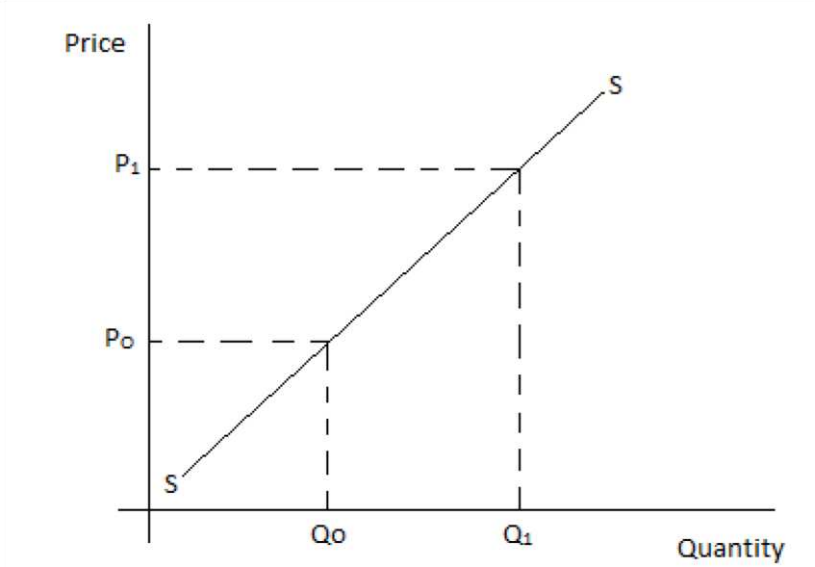
1. **Perfectly inelastic supply (P.E.S = 0)**
   This is where price changes do not affect the quantity supplied i.e. quantity supplied remains constant at different price levels.



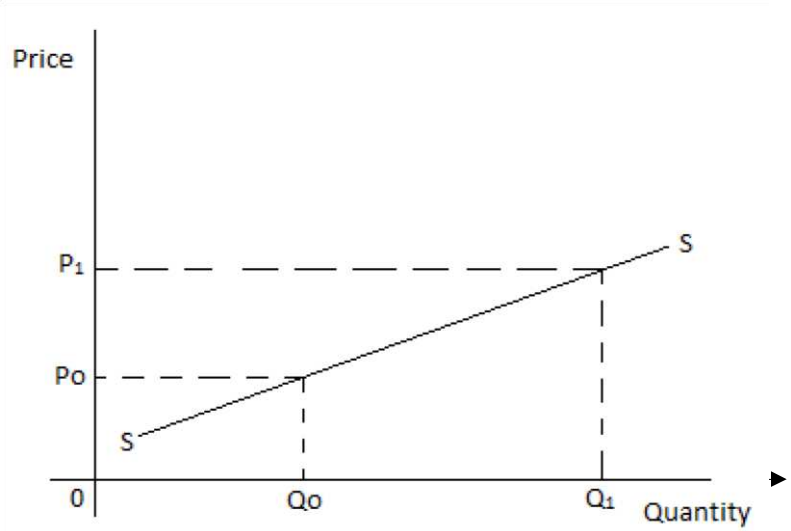
2. **Inelastic supply (0<P.E.S<1)**
   This is where a big change in price results in into a small change in the quantity supplied. This is common with agricultural products that take long to be produced.



3. **<u>Unitary supply</u> (P.E.S = 1)**
   This is where a change in price results into an equal change in the quantity supplied.
   This is an ideal situation which does not occur in reality.

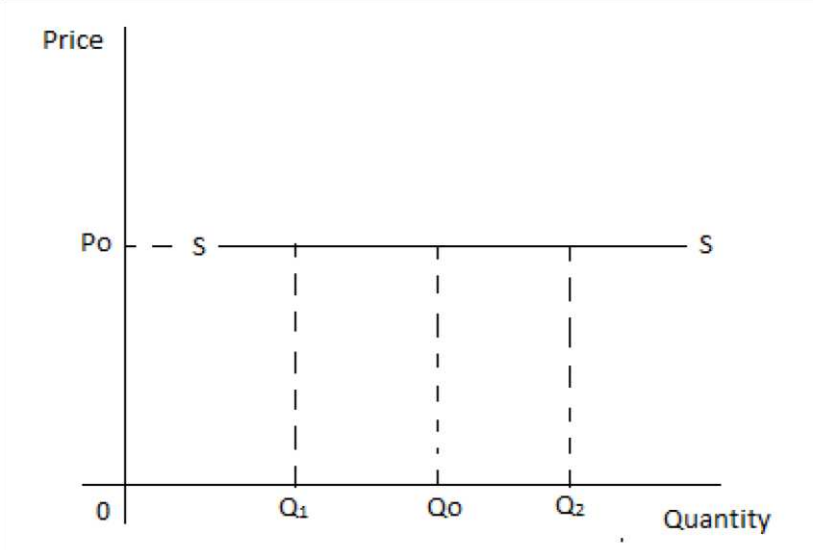


4. **<u>Elastic supply</u> (0<P.E.S<∞)**
   This is where a small change in price results into an equal change in the quantity supplied.



5. **Perfectly elastic supply**

   In this case, price of a commodity is constant at all levels of the quantity supplied. This situation does not exist in the real world.



FACTORS THAT INFLUENCE PRICE ELASTICITY OF SUPPLY

1. **The cost of production.**

   High costs of production make supply to be price inelastic because if price increases, the producers cannot be able to increase output and supply due to high expenses incurred. However, low costs of production make supply to be price elastic because if price increases, producers are in position to increase supply.

2. **Gestation period/ Length of the production process.**

   A long gestation period implies inelastic supply because if prices increase, supply cannot be increased within a short period of time. For example agricultural products with a long gestation period have inelastic supply. However, with a short gestation period like the one for manufactured goods, supply is elastic because if price increases, output can easily be increased within a short period of time.

3. **Availability of factors of production/ level of supply of factor inputs.**

   High supply of factor inputs leads to elastic supply because producers can easily increase output in response to a rise in price. However, scarcity (limited supply) of factors of production makes supply to be price inelastic because it is difficult for the producers to increase output evenif there is a rise in price.

4. **Natural factors.**

Favourable climatic conditions make supply of agricultural products to be elastic because more output can be put on the market in response to arise in price. However unfavourable climatic conditions like drought make supply of agricultural products to be inelastic because output levels cannot be increased even if there is a price increase.

5. **The level of technology used in production.**
   High level of technology such as use of modern techniques of production is associated with elastic supply because supply can easily be increased when prices increase. However, low level of technology is associated with inelastic supply because it is difficult to increase output when prices increase.
   OR
   Use of simple technology in production makes it easy to increase output in response to price increase thus supply is elastic. However, use of advanced (complicated) technology which is difficult to adopt makes supply price inelastic since it is not easy to increase output in response to a price increase.
6. **Nature of the commodity in terms of durability or perishability.**
   Durable commodities have elastic supply because they can be stored and in case of a price increase, producer/ suppliers just get commodities from their storage facilities and supply. However, perishable commodities have inelastic supply because they cannot be stored for a long period of time therefore an increase in price is not accompanied by an increase in supply.
7. **Political climate.**
   Favourable political climate in an economy makes supply price elastic because production of a commodity is encouraged due to the confidence among producers in regard to national security. However, unfavourable political climate in an economy makes supply price inelastic since production is discouraged as the producers have fear for loss of their life and property.
8. **Number of producers.**
   A commodity with many producers has elastic supply because a slight increase in price is accompanied by an increase in output by the many producers. However, a commodity with few producers has inelastic supply because if price increases, supply cannot be easily increased by the few producers.
9. **Degree of freedom of entry of new firms in the industry.**
   Free entry of new firms in the industry makes supply to be price elastic because an increase in price attracts other firms to join and increase production of the commodity. However, restricted or blocked entry of new firms in the industry makes supply to be inelastic because when price increases, other firms cannot join the industry to increase output levels.
10. **Future price expectations.**
    If producers expect a future price fall relative to the current prices, the current supply of the commodity is elastic because producers sell more now to avoid making losses in the future when the prices have fallen. However, if producers expect a future price increase relative to the current prices, current supply is inelastic because producers supply less even if prices increase because they are waiting to sell at high prices in the future and make a lot of profits.
11. **Availability of excess capacity.**
    Firms operating at excess capacity make supply to be price elastic because there is underutilisation of the production potential which makes it possible to employ more resources to increase output in response to a price increase. However, firms operating at full capacity make supply to be price inelastic because the economy is already using most of it scarce resources and thus firms find it difficult to employ more resources and thus output cannot be increased in response to a rise in price.
12. **Government policy of taxation and subsidization.**
    Favourable government policy in form low taxes, highsubsidies and other incentives makes supply price elastic because of the reduction in the average costs of production that enables the producers to increase output in response to a price increase. However, unfavourable government policy in form of high

taxation makes supply price inelastic because of the increase in the costs of production that makes it difficult for producers to increase output even if there is a rise in price.

13. **Level of development of infrastructure.**
    Well developed infrastructure in form better road networks and communication facilities makes supply to be price elastic because producers can easily increase supply in response to a price increase due to increased access to the market. However, poor infrastructure in form of poor transport facilities makes supply price inelastic because producers cannot increase output on time when prices increase.
14. **Time period in production.**
    In the short run, some factors of production are fixed and it is not easy to increase output to respond to increase in prices hence inelastic supply. However in the long run, all factors of production are variable and so it becomes easy for the producer to increase supply when prices increase hence elastic supply.
15. **Degree of factor mobility**
    Mobility of factors of production makes supply price elastic because producers can easily switch resources to production of a commodity whose price has increase. However, immobility of factors of production makes supply price inelastic because producers cannot easily switch resources to production of the commodity whose price has increased.
16. **Objectives of the firm.**
    Where producers aim at profit maximization, supply is inelastic since they limit production and supply to force the prices upwards. However, if the goal of the firm is to maximize sales, supply is elastic since more output is put on the market whenever prices increase so as to maximize sales.
17. **Price of a jointly supplied product.**
    A low price of a jointly supplied product makes supply of the commodity in question to be price inelastic because it discourages production of the commodity in question even if the price is increasing. For example a low price of maize flour makes supply of maize bran to be inelastic. However a high price of a jointly supplied product makessupply of the commodity in question to be price elastic because it encourages production of the commodity in question.
18. **Price of a competitively supplied product.**
    A high price of a competitively supplied product makes the supply of the product in question to be price inelastic because it makes production of the commodity in question unprofitable. However, a low price of a competitively supplied product makes supply of the commodity in question to be price elastic because it makes it makes production of the commodity in question profitable. **Assignment**
    Account for low price elasticity of supply in an economy.

PRICE MECHANISM (PROFIT – PRICE MECHANISM/ THE INVISIBLE HAND) AND RESOURCE ALLOCATION

Price mechanism is a system in free enterprise economy where prices in the market are determined by market forces of demand and supply with limited or no government intervention.

Price mechanism is a system where prices act as **automatic signals** in the allocation of resources.

To understand better the concept of price mechanism, we need to note the following.

1. Demand dictates what is to be supplied by the producers.
2. Consumers' expenditure is equal to seller' revenue. It means that one's expenditure on a commodity is what a seller gets as his or her income.
3. Consumers are regarded as voters. It follows that whenever consumers buy a product, they are casting votes in favour of production and supply of the commodity.
4. Consumers take an upper hand in deciding what is to be producedi.e. there is consumer sovereignty where a consumer takes a leading role in determining allocation of resources.

ASSUMPTIONS OF PRICE MECHANISM

1. It assumes existence of a free enterprise economy where resource allocation is determined by the interaction of market forces of demand and supply.

2. There is no government intervention/ interference as far as pricing and output policies of the producers are concerned.
3. There are many buyers and sellers, hence no monopoly to influence market conditions.
4. Producers aim at profit maximization and they produce commodities whose price is high.
5. Consumers aim at utility maximization and thus they buy from the cheapest source.
6. There is free entry and exit in the market i.e. when super normal profits are earned, firms are free to join the industry and when profits are exhausted, inefficient (high cost) firms leave the industry.
7. There is consumer sovereignty in the market i.e. consumers have an upper hand in deciding what is to be produced by "casting votes" to commodities as they buy.
8. It assumes no wastage of resources because producers only supply what consumers want at a particular time.
9. There is perfect mobility of factors of production, so resources go where the price is high.
10. There is perfect knowledge about market conditions by both sellers and buyers for instance consumers know the price and qualities of the products on the market.

Price mechanism responds to the basic economic questions by <u>providing appropriate answers</u> to these questions. These questions are;

- What to produce?
- How to produce?
- When to produce?
- Where to produce?
- How much to produce?
- For whom to produce?

THE ROLE OF PRICE MECHANISM IN THE ALLOCATION OF RESOURCES

NB

We consider the **functional role** of price mechanism in the allocation of resources i.e. we focus on **what price mechanism does** in the process of allocating resources in an economy.

1. **It guides on what to produce.**
   The producers are induced to produce and supply a commodity at a high price in order to make profits.
2. **It determines where to produce/ it determines the location of the production unit.**
   Producers always locate their production units in areas where demand for the goods is high and consumers are ready to buy at a price that enables them to make a profit.
   OR
   Producers decide to locate their business firms in areas with the lowest costs of production. The aim is to maximise profits through minimising costs.
3. **It determines when to produce.**
   Producers always produce more of a good at that time when demand for it is high so as to make profits.
4. **It determines how much to produce.**
   Demand dictates the quantity of goods that producers supply on the market. This checks the danger of over production and wastage is avoided.
5. **It determines for whom to produce/ it determines the distribution of goods and services.**
   Producers supply goods to those consumers who are able to buy at the prevailing market price.
   <u>OR</u>
   Producers supply goods to those consumers who have effective demand.
6. **It determines how to produce/ it determines the type of technology to be used in production.**
   Producers employ cheap but efficient techniques of production. The aim is to maximise profits through minimising costs.
7. **It guides consumers when making choice of which goods to buy.**

Holding other factors constant, consumers buy more units of a commodity whose price is low and fewer units of a commodity whose price is high.

8. **It ensures efficient allocation of resources.**
   Resources are allocated to producing those goods with the highest prices. Producers get the incentive to supply goods at high prices in order to get high profits.
9. **It determines income distribution.**
   Income is distributed among producers depending on the price at which they supply and sell their goods. Therefore, producers who supply goods at high prices earn more incomes than those who supply goods at low prices.
10. **It provides an incentive for economic growth.**
    This arises where high prices encourage high production of goods and services. As more goods and services are produced, economic growth is attained.
11. **It ensures production of better quality products because of competition among producers.**
    Producers compete for the available market in order to supply their goods. Due to this competition, better quality goods have to be produced so that producers maintain and increase the level of demand for their goods.

IMPLICATIONS OF PRICE MECHANISM

POSITIVE IMPLICATIONS (MERITS)

NB:

Here we focus on the positive outcomes/ desirable outcomes (good things) which arise from price mechanism.

1. **It promotes consumer sovereignty.**
   Individual households make their own decisions since the consumers influence what is to be produced. The goods and services which consumers demand for are the ones produced and supplied.
   The consumer becomes a **king** in influencing productive activities.
2. **It ensures efficiency of firms.**
   Firms strive for efficient operations so as to survive competition and sell at high prices since high prices lead to high profits. This enables producers to expand their scale of production and become more efficient
3. **It encourages competition which leads to production of better quality goods and services.**
   Consumers are more willing to pay a high price for high quality goods. Therefore producers strive to get the high prices by improving the quality of commodities.
4. **The profit motive encourages innovations and inventions (research).**
   Due to the profit motive, producers develop new and better techniques of production. The improved methods of production result into increased output of better quality which is sold at high prices. This enables producers to get more profits.
5. **It avails a wide variety of goods and services to consumers.**
   Price mechanism generates competition among producers. This gives rise to a greater variety of goods and services in an economy. Consumers are able to exercise choice and their standard of living is improved.
6. **It leads to efficient allocation and utilization of resources.**
   Price mechanism enables producers to allocate the scarce resources in the production of those goods needed by the consumers. Producers allocate more resources to those goods whose demand is high and fewer resources are allocated to those goods whose demand is low.
7. **It leads to increased employment opportunities.**
   As prices of goods rise (increase), producers supply more of those goods. Producers expand their scale of production and more people get employed in production units.

8. **It promotes incentive for hard work among producers leading to increased production.** High prices of goods motivate or encourage producers to work hard and supply more goods to consumers. This promotes economic growth in the country.
9. **It reduces the costs of administration due to limited or no government intervention.**
   The forces of demand and supply guide the allocation of resources without government interference using price controls. The government does not incur costs of enforcing minimum and maximum prices.
10. **It helps to reward the various factors of production in the factor market.**
    Factors which enable production of goods with high demand and prices are paid higher rewards. However, those factors whose output has low demand and low prices are paid low rewards.
11. **It encourages flexibility in production.**
    Producer use the price and profit signals to change from less profitable to more profitable economic activities. For example a coffee farmer may change from the growing of coffee to the growing of vanilla should the price of vanilla become higher than that of coffee.
12. **It encourages arbitrage which benefits producers.**
    Producers transfer goods from areas with low prices to sell them in areas with high prices. This benefits producers because they earn more revenue from sales and subsequently make higher profits.

    NB:

    Arbitrage is the practice of transferring goods from areas with low prices to areas with high prices in order to gain from the difference in prices. For example if a bag of in Jinja costs shs 120,000 and it costs shs 150,000 in Kampala, a trader may transfer bags of sugar from Jinja and sells them in Kampala so that he gains from that difference in price.

NEGATIVE IMPLICATIONS / DEMERITS/ DEFECTS/ WEAKNESSES/ SHORTCOMINGS/ DISADVANTAGES OF PRICE MECHANISM

NB:

Here we focus on those **undesirable outcomes or bad things** associated with price mechanism.

1. **It leads to consumer exploitation by producers due to ignorance or market imperfections.**
   Price mechanism assumes that a consumer has perfect knowledge about the market conditions. However, many consumers are not aware of price changes and new goods on the market and thus they are exploited by profit – hungry producers.
2. **It leads to emergence of monopoly and its negative consequences.**
   Price mechanism creates private monopoly because of excessive competition which forces inefficient firms out of production and efficient firms take over the market. The monopoly firms restrict output in order to charge high prices. They also supply low quality goods due to absence of competition in the market. This leads to exploitation of consumers.
3. **It promotes income inequality.**
   Efficient producers whose goods are highly demanded receive higher incomes than the inefficient producers. Therefore the efficient producers get access to most of the resources in the economy. This creates income disparity with its associated disadvantages of exploitation of the poor by the rich.
4. **It encourages divergence between social costs and private benefits.**
   Price mechanism does not consider the negative effects inflicted on the society as producers exploit the natural resources. Private investors benefit through profit maximization without taking into account social costs. For example when forest trees are cut down to get timber, there is a danger of deforestation and its negative impact on the environment, pollution created by private enterprises, over exploitation of resources. Unfortunately, these social costs are not considered under price mechanism.
5. **It leads to unemployment.**
   This is due to automation (use of capital intensive techniques of production) and out competition of inefficient firms making people who were employed in those firms to lose jobs. The unemployed people experience low standards of living.

6. **It leads to economic instabilities like inflation, price fluctuations and balance of payments problems**.
   This is due to absence of government intervention.
7. **It leads to underutilization of resources.**
   Price mechanism creates excess capacity in certain cases. Producers abandon production of those goods which are not highly demanded. This leaves some resources to be idle or underutilized.
8. **It leads to wastage of resources due to wasteful competition.**
   Price mechanism brings about stiff or cut-throat competition among private investors. Excessive competition among producers leads to resource wastage.
9. **It fails to allocate resources in priority sectors i.e. it does not provide public and merit goods/ it ignores socially profitable ventures.**
   Price mechanism is not used to provide public goods such as public hospitals, roads and schools. The provision of such socially desirable goods is done by the government.
10. **It does not respond quickly or adjust quickly to structural changes in an economy.**
    Price mechanism does not respond to circumstances requiring rapid structural changes such as privatization, modernization of agriculture, liberalization of trade, alleviating effects of natural disasters, etc. Such rapid structural changes call for government intervention.
11. **It leads to distortion of consumer choices through persuasive advertising.**
    As private investors try to capture market for their goods, they undertake persuasive advertisements. As a result, many consumers end up buying goods which they would not have bought and thus their choices are distorted.
12. Foreign dominance of an economy is prominent most especially if the economy is open.
13. It leads to disappearance of cheap goods from the market because private individuals only venture in activities that enable them maximize profits.
14. It makes government planning difficult since it is associated with a number of uncertainties.

METHODS/ WAYS OF INTERFERING WITH PRICE MECHANISM

1. **Use of taxation policies.**
   For instance adoption of Progressive taxation policy helps in redistributing income in an economy because the tax rate increases with increase in the tax payer's income i.e. it takes a higher proportion of income of the rich than the poor hence narrowing the gap between the rich and the poor. Taxation can also be used to influence resource allocation whereby for sectors government wants to promote, no taxes are levied on their activities while for sectors and activities that government finds less desirable, high taxes are levied on them.
2. **Provision of public goods by the government.**
   For example the provision of better transport network in form of roads helps in the movement of goods from areas where they are in plenty to those areas where goods are scarce. Hence shortages of goods created through the market forces of demand and supply are solved or checked.
3. **Encouragingthe setting up of consumer protection associations.**
   These help in sensitizing the consumers about the ways in which they can be exploited by profit – hungry traders. The consumers are educated on how they can safeguard themselves against buying expired goods and adulterated goods as well as other forms of exploitation by traders.
4. **Anti-monopoly legislation**
   Government enacts laws aimed at checking monopoly powers of private producers or investors. This is aimed at reducing consumer exploitation associated with monopoly firms.
5. **Setting up regulatory bodies to minimize social costs.**
   Such bodies set laws which govern exploitation of resources, laws that protect wetlands, laws that enforce proper disposal of industrial wastes, etc. A case in Uganda is The National Environment and Management Authority (NEMA) that was set up to protect the environment.

6. **Setting up and strengthening bureau of standards.**
   A bureau of standards is in charge of inspecting goods being produced to ensure that certain quality specifications are fulfilled before goods are put on the market. A certification mark is given for goods that fulfill the required quality standards and this protects the health of consumers.
7. **Licensing.**
   The government puts certain restrictions on the licensing of traders such that licenses are given to only those traders or enterprises approved by the licensing department. This checks the carrying out of illegal or illicit trade.
8. **Planning for the economy.**
   Economic development plans are drawn up by the government to guide the allocation of resources in both the private public sector. The aim is to avoid misallocation of resources associated with price mechanism.
9. **Subsidization of firms especially those providing essential and merit goods.**
   The government offers subsidies to firms to produce essential goods and services so that the consumers are able to get such goods and services at lower prices.
10. **Adoption of price legislation policy/ control.**
    Price controls are taken to even out fluctuations in prices. The government can either set a maximum price to protect consumers or a minimum price to protect producers depending on the economic situations at that time.
11. **Setting up government owned firms to compete with private monopolies.**
    Government can set up non-profit making enterprises which are vital to the society. Such enterprises can compete with the private producers thus reducing on consumer exploitation.
12. **Carrying out nationalization of private enterprises.**
    This is done to ensure that all essential goods and services are produced and supplied by nationalized enterprises at fair prices.
13. **Rationing of scarce commodities.**
    It involves direct action by the government to distribute the scarce commodities to the public at fixed prices in limited quantities. This is done in periods when goods are scarce in order to reduce consumer exploitation by the traders. For example in 1986 – 1987, the government of Uganda used this policy by rationing the supply of essential goods like sugar, salt, soap to consumers through local councils.
14. **Controlling/ fighting inflation.**
    The government through the central bank uses a restrictive monetary policy to reduce the amount of money in circulation. This reduces the purchasing power of households/ public. Consequently, aggregate demand falls and prices become stable.
15. **Use of buffer stocks.**
    A buffer stock is a system or scheme which buys and stores stock in times of plenty and releases the stocks in times of scarcity. The buffer stock is managed by the government and it helps in stabilizing prices of goods on the market.

REASONS FOR GOVERNMENT INTERFERENCE IN PRICE MECHANISM

Due to the weaknesses or defects of price mechanism, government interferes in the allocation of resources through the forces of demand and supply for the reasons below;

1. **To reduce consumer exploitation by the profit – hungry business community.**
   This arises due to consumer ignorance/ market imperfections. The profit – hungry traders exploit consumers through over charging, sale of fake products, product adulteration, sale of expired goods etc. Such trade malpractices call for government intervention through setting up and strengthening the bureau of standards.
2. **To control monopoly power in an economy where consumer preference is ignored.**

The government intervenes by imposing heavy taxes on the profits of monopolists. The aim is to fight the dangers associated with private monopolies such as overcharging of consumers and production of poor quality goods.

3. **To reduce income inequality.**
   The government intervenes through progressive taxation so as to reallocate resources and attain equity in income distribution.
4. **To minimise social costs that arise as private investors pursue their private gains.**
   Such costs include over exploitation of resources, pollution of the environment, deforestation among others. The government intervenes by setting up regulatory bodies that enact laws geared to protecting the environment by regulating the actions of firms during resource exploitation.
5. **To reduce unemployment which arises as inefficient firms are outcompeted.**
   The government intervenes by subsidising the inefficient firms to enable them lower their production costs and survive the stiff competition. This guards against unemployment.
6. **To reduce economic instabilities like inflation i.e. to stabilize the economy.**
   The government intervenes through price controls to ensure stability in prices of goods and incomes of producers.
7. **To cater for the provision of public goods.**
   Goods such as public roads andnational security cannot be provided through the market forces of demand and supply hence a need for government interference.
8. **To encourage production and consumption of merit goods.**
   These include education, medical care and safe water. A case in Uganda is the funding of the Universal Primary and Secondary Education by the government.
9. **In order to plan for rapid structural changes in the economy that cannot be handled by price mechanism.**
   Structural changes such as rehabilitation of basic infrastructure after periods of war, privatization and modernization of agriculture call for government interference.
10. **For purposes of avoiding duplication of activities.**
    The government intervenes by setting up one public enterprise to run an activity. This avoids wastage of resources.
11. **To control distortion of consumer choices.**The government intervenes by legislating prices of commodities so as to avoid consumer exploitation by the producers in form of persuasive advertising.
12. To encourage investment in areas that may appear risky.
13. **To provide goods needed by the poor.**
    In some cases, government subsidises such goods so that they become affordable to the poor people in the economy. The aim is to improve the quality of life of the poor people.

LIMITATIONS OF PRICE MECHANISM

In this case, we focus on those factors that slow down or distort the effective allocation of resources through the price mechanism. A student needs to be well versed with the assumptions of price mechanism.

1. **Government intervention/ interference.**
   In most economies, government interferes with the inter-play of market forces through price controls and taxation policies. This discourages some producers and they reduce the amount of goods supplied on the market. In this case, supply does not match with the consumers' demand and price mechanism is distorted.
2. **Ignorance of the producers and consumers.**
   Generally, producers and consumers do not have perfect knowledge of the market conditions. Some producers tend to supply goods without judging the condition in the market. Consumers too are not

always aware of the availability of certain products and their prices. This creates slow response between demand and supply hence limiting price mechanism.

3. **Existence of monopolies**
   There are many monopolies who tend to be price makers. They always restrict output in order to charge high prices and exploit consumers. They do not supply goods according to the demand by the consumers and this distorts the use of price mechanism in the allocation of resources.
4. **Limited entrepreneurial skills.**
   Poor organization of factors of production and failure to take risks limits producers from responding to consumers demands. Producers fail to supply those goods needed by consumers and this slows down the operation of price mechanism.
5. **Under developed infrastructure.**
   A poor road network limits the supply of goods to areas where they are needed. Consumers may desire to buy goods but are not accessible due to poor transport and distribution network.
6. **Inability to forecast future trends.**
   Failure of producers to anticipate increased demand in future gives rise to low output and this leads to scarcity of goods. Alternatively, over production can occur where producers anticipate increased demand yet actual demand is low. This creates a gap between demand and supply hence price mechanism is distorted.
7. **Limited capital.**
   Inadequate supply of real and money capital leads to low output. This makes producers to supply less than what is required by consumers. As a result, shortages of goods arise on the market hence limiting the operation of price mechanism.
8. **Limited skilled labour.**
   The existence of few people with the necessary and relevant skills makes supply not to respond to the demand of consumers because of fewer volumes of goods being suppliedhence limiting the effective operation of price mechanism.
9. **Immobility of factors of production.**
   Some factors of production do not move with ease from one place of work to another or from one geographical area to another. Therefore producers may fail to increase output hence supply does not respond to demand thus limiting the operation of price mechanism.
10. **Irrationality of producers and consumers.**
    Price mechanism assumes that producers and consumers are rational which is not always true. Many producers and consumers are not guided by a calculating mind.
11. **Reliance on imported goods.**
    This makes local consumers to have little influence on prices, quality, designs, etc of such imported goods.
12. **Band wagon effect.**
    Many people consume certain commodities because they have seen others consuming them. Therefore price mechanism may not operate since such consumers are not rational.

PRICE LEGISLATION

Price legislation is where the government fixes prices of commodities that is either maximum price to protect consumers or minimum price to protect producers.

OR

Price legislation is the deliberate government act of fixing price either above or below the equilibrium and it becomes illegal to sell below or above respectively. Price control or legislation takes two major forms namely;

1. Maximum price legislation.
2. Minimum price legislation.

MAXIMUM PRICE LEGISLATION

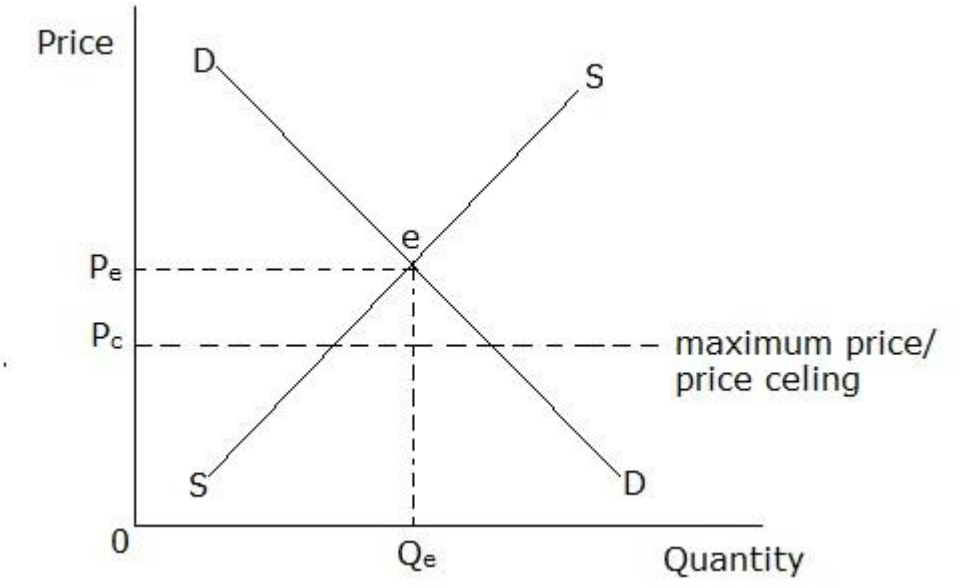
This is the setting/ fixing of prices of commodities by the government below the equilibrium price above which it becomes illegal to sell or buy a commodity. It protects consumers.

The result of maximum price legislation is a maximum price/ price ceiling.

Maximum price/ price ceiling

Refers to the price set by the government below the equilibrium price above which it becomes illegal to sell or buy a commodity. It protects consumers.

Illustration



OPe = equilibrium price

OQe = equilibrium quantity demanded or supplied

OPc = maximum price/ price ceiling

It should be noted that no seller is allowed to sell above OPc which is the maximum price.

MERITS OF MAXIMUM PRICE LEGISLATION

1. Protects consumers from exploitation by producers through over charging.
2. Controls monopoly power since monopoly to a greater extent is a price maker.
3. Avails commodities to all groups of people in the economy. A maximum price makes the commodity affordable to all people and therefore more units are bought.
4. Reduces income inequality because it reduces the profits of producers and expenditures of consumers.
5. Controls inflation because the price is set below the equilibrium price and it is illegal to sell or buy above it.
6. Widens consumers' choice thereby improving on peoples' standards of living.
7. Helps to increase on aggregate demand thus stimulating investment and economic growth.
8. Discourages production of harmful products such as alcohol, cigarettes, marijuana, etc and this benefits the entire society.
9. Discourages importation of expensive commodities and encourages exports. This increases the foreign exchange earnings of the country.

DEMERITS

1. Discourages entrepreneurship development since it reduces the profit margins of producers.
2. Results into shortages of commodities since the legislated prices tend to be less attractive to producers.
3. Leads to trade malpractices such as black marketing, hoarding of commodities, smuggling hence reducing the supply of goods and services in the market.
4. Results into production at excess capacity as a number of resources are not put into use.

5. It leads to rationing. This is because it creates scarcity of goods and as a result, the government is forced to restrict the consumption of scarce commodities on the basis of first come first serve hence leading to problems like long queues and nepotism.
6. It leads to increased government expenditure due to high administrative costs incurred by the government to employ the scouts and enforcement officials to visit all parts of the country so as to ensure that goods are sold at the legislated prices.
7. It leads to unemployment due to reduced levels of investment
8. Deflation may arise and this if not checked may lead to economic depression.

NB:

Rationing is the government act of selling scarce commodities to households in fixed quantities at fixed prices on the basis of first come first serve.

ASSIGNMENT

Outline the objectives of maximum price legislation.

MINIMUM PRICE LEGISLATION

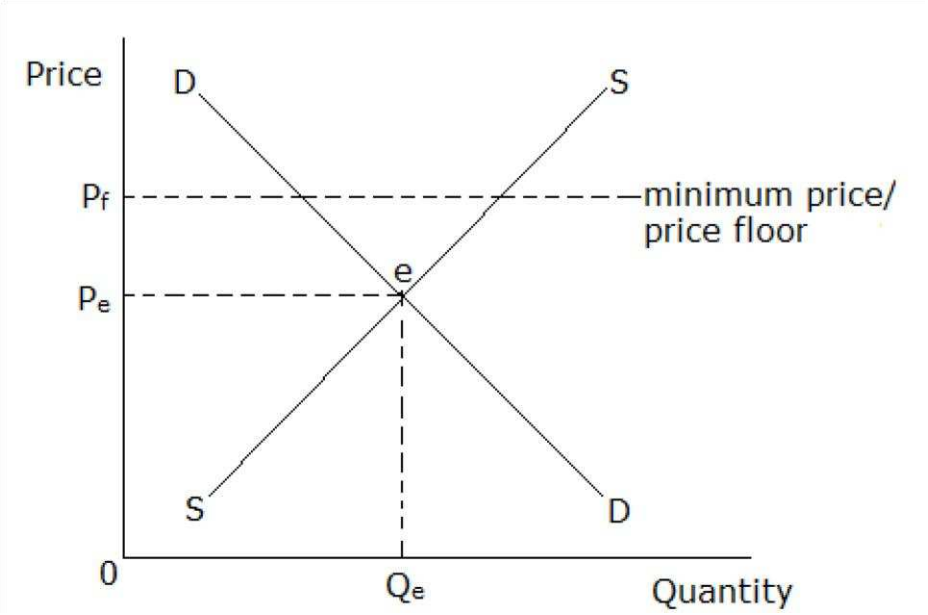
Is the fixing/ setting of pricesof commodities by the government above the equilibrium price below which it becomes illegal to sell or buy a commodity. It protects producers.

The result of minimum price legislation is a minimum price/ price floor.

MINIMUM PRICE/ PRICE FLOOR

Refers to the price set by the government above the equilibrium price below which it becomes illegal to sell or buy a commodity. It protects producers.

Illustration



OPe = equilibrium price

OQe = equilibrium quantity demanded or supplied

OPc = minimum price/ price floor

MERITS OF MINIMUM PRICE LEGISLATION

1. Protects producers from exploitation by consumers through under charging. This basically applies to producers of agricultural goods. The buyers are not allowed to get produce from farmers at a price below the legislated price.
2. Increases output levels because it encourages more production in an economy hence economic growth and development.
3. Enables producers to realize stable incomes since it minimizes price fluctuations.

4. Minimizes consumption of harmful products such as alcohol, cigarettes, marijuana, etc. This is because the price is set above the equilibrium price hence making the products unaffordable by consumers.
5. Increases government revenue because the government is in position to charge reasonable taxes on profits received by producers.
6. May help an economy to offset economic depression or recession since it tends to activate investments/ production in the economy.
7. Minimizes smuggling of goods to other countries since producers are satisfied with home prices.
8. Increases employment opportunities as a result of increased production of commodities and trade in the economy.
9. Promotes research due to the high profits received by the producers which leads to production of better quality products hence better standards of living.

DEMERITS

1. Causes surplus output because of excess production hence wastage of resources.
2. Leads to increased costs of productionsince it is a high price and mainly set for primary products which form a major part of raw materials especially for agro – based industries.
3. A minimum price in form of minimum wage makes labour expensive forcing producers to opt for alternative methods of production instead of hiring expensive labour e.g. some producers start using more machines compared to men. This results into technological unemployment.
4. Leads to storage problems due to unmanageable surplus.
5. Leads to reduction in social welfare because of high costs of living.
6. Leads to over exploitation of resources which leads to exhaustion of some non-renewable resources like minerals.
7. Leads to smuggling of goods into the country making government to lose a lot of revenue required to meet its expenditure needs.
8. It is inflationary since there is no maximum. A minimum price makes it only illegal to set a lower price but sellers can set any price above it.
9. Widens income disparities between producers and consumers since it increases the profits of producers and expenditure of consumers.
10. It encourages dumping of commodities to other countries. Dumping has negative effects on the recipient country such as closure of local firms due to their out competition, under utilization of local resources among others.
11. Farmers are discouraged in the long run in case the government fails to buy the surplus output.

NB:

1. Dumping refers to the selling of a commodity in the external market at a lower price than the one charged in the local market.
2. Price support is where the government buys the surplus output on the market arising from the fixing of the minimum price.

ASSIGNMENT

1. Outline the objectives of maximum price legislation?
2. Under what circumstances may government employ a price control policy?
3. Examine the effects of price control in an economy.
4. Why may the use of price controls be avoided in an economy?

CIRCUMSTANCES UNDER WHICH GOVERNMENT MAY EMPLOY A PRICE CONTROL POLICY

A price control policy may be employed under the following circumstances.

1. When consumers are being exploited. In this case, the government fixes a maximum price.
2. When there is existence of monopoly and its consequences → maximum price.
3. When essentials of life are unaffordable to consumers → maximum price

4. When there is need to reduce income inequality → maximum price
5. When producers are being exploited → minimum price
6. When there is desire to attain higher levels of output (economic growth) → minimum price
7. When there is need to maintain industrial peace → minimum price
8. When there is need to stabilize producers' incomes → minimum price
9. When there is need to offset an economic depression/ recession → minimum price
10. When government wants to discourage production and consumption of harmful products → both **11.** When there are price instabilities → both.

EFFECTS OF PRICE CONTROLS

POSITIVE EFFECTS

1. Maximum price protects consumers from exploitation by producers through over charging.
2. Maximum price controls monopoly power.
3. Maximum price avails commodities to all groups of people in the economy.
4. Maximum price reduces income inequalities.
5. Maximum price widens consumers' choice
6. Maximum price helps to increase on aggregate demand
7. Maximum price discourages importation of expensive commodities and encourages exports. This increases the foreign exchange earning of the country.
8. Minimum price protects producers from exploitation by consumers through under payment.
9. Minimum price increases output levels.
10. Minimum price enables producers to realize stable incomes.
11. Minimum price increases government revenue.
12. Minimum price may help an economy offset an economic depression or recession.
13. Minimum price increases employment opportunities.
14. Minimum price promotes research.
15. Price control maintains price stability
16. Price control checks on the production and consumption of harmful products.
17. Price control eliminates trade malpractices such as black marketing, smuggling of goods, etc.

NEGATIVE EFFECTS

1. Maximum price discourages entrepreneurship development.
2. Maximum price results into shortages.
3. Maximum price results into production at excess capacity.
4. Maximum price leads to unemployment due to reduced level of investments.
5. Minimum price causes surplus output hence wastage of resources.
6. Minimum price leads to increased costs of production.
7. Minimum price leads to storage problems due to unmanageable surplus.
8. Minimum price leads to reduction in social welfare because of high costs of living.
9. Minimum price leads to over exploitation of resources.
10. Minimum price causes inflation since there is no maximum.
11. Minimum price widens income disparities between producers and consumers.
12. Price controls encourage trade malpractices such as black marketing, smuggling, etc.
13. Price controls call for establishment of marketing boards which leads to exploitation of consumers.
14. Price controls lead to misallocation of resources due to distortion of price mechanism.
15. It is expensive for the government to enforce price controls.

REASONS FOR AVOIDANCE OF PRICE CONTROLS

1. Fear of causing trade malpractices such as smuggling, black marketing, etc. Maximum price legislation leads to smuggling of goods to other countries while minimum price legislation leads to smuggling of goods into the country.

2. Fear of raising costs of production which arise out of high costs of raw materials resulting from minimum price legislation.
3. Fear of causing unemployment resulting from maximum price legislation which forces firms to close down as they cannot cover their average costs.
4. To avoid unmanageable surpluses and storage problems in case of a minimum price.
5. To avoid discouraging entrepreneurs through tampering with their profit margins in case of a maximum price.
6. To avoid high administrative costs on these price controls e.g. price support.
7. To avoid unnecessary distortion of the price mechanism which may lead to misallocation of resources.
8. Fear of reducing social welfare of the people due to high cost of living caused by minimum price legislation.
9. To avoid underutilization of resources in case of a maximum price.
10. Fear of causing shortages of goods and services resulting from maximum price legislation which discourages production.

AGRICULTURE IN RELATION TO DEMAND AND SUPPLY

The nature of demand and supply in the agricultural sector tends to be unstable and this in turn tends to make prices of agricultural products fluctuate more often compared to the prices of industrial products or manufactured goods.

AGRICULTURAL PRICE FLUCTUATIONS

Agricultural price fluctuations refer to instabilities or changes in prices of agricultural products over a given period of time.



CAUSES OF AGRICULTURAL PRICE FLUCTUATIONS

1. **Divergence between planned output and actual output.**
   When the actual output of farmers is greater than the planned output, over production arises leading to a fall in prices for the planned output. However where actual output is less than the planned output, there is shortage on the market hence causing the prices to increase.
2. **Long gestation period of agricultural products.**
   The long gestation period of some crops makes supply to be inelastic. Before harvesting season, there is a shortage of agricultural products in the market and this leads to an increase in prices. However after harvesting, supply of agricultural products is increased on the market and this leads to a fall in prices being offered to producers.
   NB:
   Gestation period is the time it takes before new supplies of goods reaches the market for example maize takes 3-4 months while mushrooms take 1 month.
3. **Low income elasticity of demand for agricultural commodities.**
   The demand for agricultural products is not influenced by changes in income i.e. changes in income have minimal impact on the demand for agricultural products. During seasons of high supply, surplus is created on the market and this leads to a fall in prices. However, a fall in supply leads to an increase in prices.
4. **Low price elasticity of demand (inelastic demand) for agricultural commodities.**
   The demand for agricultural products is inelastic such that even if prices change, consumers demand almost the same quantities. This implies that change in supply is not followed by change in demand hence leading to continuous change in price levels i.e. surplus output pushes the prices downwards and shortages push the prices upwards.
5. **Changes in the costs of production.**

Farmers incur costs of production in form of buying seeds, fertilizers, farm equipments, hiring tractor services etc. When they incur high costs of production, they increase the prices for their products and when they incur lower costs of production, they reduce the prices hence price fluctuations.

6. **Perishability of agricultural products hence difficult to store.**
   Most of the agricultural products are perishable and thus cannot be stored for future use. This causes prices to fall during harvesting periods because farmers tend to sell all their produce. On the other hand during non-harvesting periods, there is severe shortage because little or nothing was stored during the harvesting period and consequently prices go up.
7. **Bulkiness of agricultural products hence difficult to transport.**
   Agricultural products are bulky and this makes them difficult to transport from production areas to market centres. This leads to a fall in prices at the production centres and a rise in prices at the market centres.
8. **Lack of co-operation among producers of agricultural products.**
   Presence of many farmers competing amongst themselves makes it hard to regulate output in order to stabilize prices. When producers enjoy high prices of products in one season, many farmers are attracted to grow the same crop in the coming season. This results into massive output leading to a fall in prices. When producers make losses, many farmers are discouraged and stop growing the crop. This results into shortages in the next season forcing prices to rise.
9. **Heavy dependence on nature/ effects of changes in natural factors like weather, soils, etc which affect output levels.**
   Unfavourable climatic factors like prolonged droughts, floods, pests and diseases in some seasons result into low output leading to an increase in the price of agricultural products. On the other hand, favourable climatic conditions lead to greater output by the farmers resulting into declining prices of agricultural products.
10. **Substitution of agricultural raw materials with artificially made raw materials by developed countries/ high competition from synthetic/ artificial fibres.**
    Some agricultural products like cotton face stiff competition from synthetic fibres like nylon, silk, polyester, etc. Where buyers prefer synthetic fibres to natural fibres, the price of natural fibres falls. However, when the demand for synthetic fibres declines, buyers resort to natural fibres and their prices increases.
11. **Introduction of raw material saving techniques by developed countries (major buyers).**

Raw material saving innovations have tended to interfere with planning output in the agricultural sector thereby causing instabilities in supplies and hence instabilities in prices of agricultural products. **12. Weak bargaining position of LDCs on the world market/ external determination of prices**

The major buyers (MDCs) dictate the prices of agricultural products like coffee, cotton, tea etc. As a result, LDCs cannot secure stable prices for their products because the major buyers increase and decrease the prices since they are more or less price makers in the foreign markets hence price fluctuation.

13. **Agricultural products are only minor inputs in the manufacturing sector.**
    The agricultural products used as inputs in the production of industrial products form a small part. E.g. in the manufacturing of cars, agricultural products are only used in the making of tyres making their demand inelastic.
14. **Poor surplus disposal system/ machinery.**
    Developing countries are faced with a problem of poor infrastructure such as underdeveloped transport facilities making it difficult to transport the surplus to areas of scarcity. This leads to a fall in prices in the areas where there is surplus output and a rise in prices in areas of scarcity.

EFFECTS OF AGRICULTURAL PRICE FLUCTUATIONS ON AN ECONOMY

1. **Price fluctuations lead to fluctuations in farmers' incomes.**

Incomes of farmers increase when prices increase and they decrease when the prices decrease.

2. **Price fluctuations result into <u>fluctuations in government revenue</u>.**
   This is because government receives most of the revenue from taxing income and/ or property. Therefore fluctuation in income means fluctuation in tax revenue.
3. **Fluctuations in prices of major export crops lead to <u>instability in export earnings</u>.**
   In seasons when export prices increase, export revenue for the government increases. However in seasons when export prices fall, export revenue also declines. This causes unstable export earnings from one season to another.
4. **Government planning based on expected earnings from the agricultural sector <u>becomes difficult</u>.**
   When prices are fluctuating, it is not easy to predict what is to be earned from selling agricultural products. This complicates planning by the government in case the plans are to be financed by incomes from the agricultural sector/ agricultural exports.
5. **Farmers get <u>discouraged/ frustrated</u>.**
   This leads to subsistence production hence a decline in economic growth and development.
6. **Price fluctuations lead to <u>rural urban migration</u> with its negative consequences.**
   As incomes from agriculture become unreliable, the frustrated farmers (especially the young and energetic) migrate to urban areas looking for better employment avenues/ opportunities. Unfortunately, this migration is associated with many problems like open urban unemployment, high crime rate, development of slums, gambling, etc.
7. **Price fluctuations lead to <u>instability in exchange rates</u>.**
   As export prices of agricultural products increase, a country's foreign exchange earnings are improved. This results into greater foreign exchange inflow. This increased inflow of foreign currency results into a fall in exchange rates in the country. However, a fall in export prices of agricultural products creates a shortage of foreign currency in the country. This results into an increase in exchange rates.
8. **Price fluctuations lead to <u>instabilities in balance of payments</u>.**
   An increase in export prices of agricultural products in a given season results into an improvement in the balance of payments position.On the hand, a fall in export prices of agricultural products in a given season results into worsening of the balance of payments position.
9. **Price fluctuations result into <u>unstable/fluctuating terms of trade</u>.**
   When prices of agricultural exports increase, the terms of trade improve (become better). However when export prices decline, the terms trade deteriorate (become worse).
10. **<u>Investment</u> in agriculture <u>becomes uncertain</u>**.
    This causes speculation as farmers regard investment in agriculture as a gamble and thus <u>irrational</u> use of land.
11. **Price fluctuations lead to <u>seasonal unemployment</u> in the sector.**
    Some farmers may decide not to produce in a particular season because of the miserable prices obtained in the past season. Such farmers become seasonally unemployed.
12. **Price fluctuations <u>worsen income inequalities.</u>**
    A decline in prices of agricultural products in some seasons makes farmers to earn less income than individuals employed in other sectors like the industrial sector, service sector, etc.

<u>ASSIGNMENT</u>

Why is there need to stabilize agricultural products?

<u>POSSIBLE WAYS OF STABILISING AGRICULTURAL PRICES</u>

1. **Through operation of the buffer stock policy.**
   A buffer stock policy is one whereby the government through the market boards buys the surplus output from farmers, stores it and sells it during periods of scarcity. This helps to iron out fluctuations in supply, prices and incomes.
2. **By use of the stabilization fund policy.**

A stabilization fund policy is the deliberate attempt by the government of paying the producers less than the market price when prices and incomes are high and putting the realized difference into a fund and later using the fund to pay the producers higher prices than the market price when prices and incomes are low to avoid fluctuations in prices and incomes as would be dictated by the market forces.

3. **Improving on storage facilities/ system**
   For example use of fridges to ensure proper storage of highly perishable products like milk, fish, tomatoes etc. This stabilizes supply and hence prices and incomes of agricultural producers.
4. **Improving on transport system.**
   This involves construction of feeder and main roads linking production centres and market centres. A better transport system evens out surpluses by easing transportation of goods from production centres (areas of plenty) to market centres (areas of scarcity) thereby stabilizing prices of agricultural products.
5. **Modernizing agriculture/ improvement in technology and carrying out extensive research.**

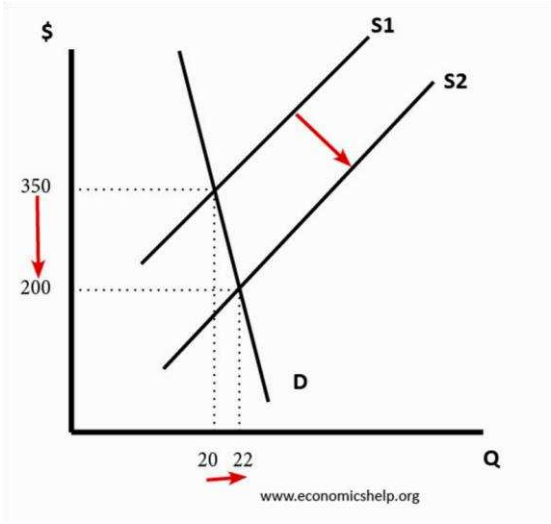
This not only improves on the quality of agricultural products but also leads to a reduction in their gestation period. For example use of hybrid seeds with a short gestation period, taming nature through irrigation, etc. All these stabilize supply leading to stable prices over time.

6. **Setting up agro-based industries.**
   Agro-based industries add value onto agricultural products. This helps to improve on the quality and prices of agricultural products.
7. **Joining international commodity agreements.**
   International commodity agreements like international coffee agreement help to fix prices and quotas for the buyers and sellers of commodities to avoid fluctuations of prices on the world market resulting from excess supply.
8. **Diversifying agriculture.**
   It is important to note that many developing countries depend on only one or two crops for export. As a result, fluctuations in the output or prices of the crop(s) may cause considerable instability in exports and incomes of those countries. To reduce the effects of dependence on one or a few crops, there is need to produce a variety of crops so that failure of one can be compensated for by the successful harvest of the other(s).
9. **Development of forward (future) markets/ contract trade**
   This involves producers and buyers signing agreements specifying the amount, quality and price of a given commodity to be supplied in the future. In this way, changes in supply do not affect the price agreed upon hence stability in prices of agricultural products. Future trade can be arranged for both local and foreign trade.
10. **Through price legislations.**
    The government of the concerned economy can carry out price controls by fixing prices of selected commodities.
11. **Formation of co-operatives to control supply.**
    Co-operatives help to educate the farmers about the use of better farming methods, looking for market for the farmers' output, regulating supply through a quota system, improving the bargaining abilities of farmers with buyers, etc. All these actions help to stabilize the prices of agricultural products.
12. **Strengthening regional economic integration.**
    This improves the bargaining power of member states for their agricultural exports on the world market.
13. **Diversifying and expanding the markets for agricultural products.**
    This involves extending and widening markets for agricultural products. It is done by searching for new buyers from other developing countries in Asia and in other parts of Africa.
14. **Re-sale price maintenance system.**
    It is important to note that greater fluctuations are at times caused by middlemen and if prices at which consumers are to buy are set in advance by the primary producers, instability in prices may be minimized.
15. **Subsidising farmers/ providing tax incentives to farmers/ stabilising costs of production.**
    This involves reducing taxes on farm inputs or provision of subsidies to farmers on farm inputs. This helps to stabilise costs of production and ensure stable supply and prices.
16. **Providing affordable credit to farmers to buy necessary inputs.**
    This involves providing low interest loans to farmers through the local SACCOs and commercial banks to enable purchase of farm inputs. This leads to stable supply of agricultural products and thus stable prices.

EFFECT OF A CHANGE IN SUPPLY UNDER CONDITIONS OF INELASTIC DEMAND

With inelastic demand, small change in supply can have a large impact on changing price.

Illustration



From the diagram above, it can be observed that a small increase in supply (represented by a shift of the supply curve to the right from S_1S_1 to S_2S_2) leads to a big fall in price from P_2 to P_1. Note that a fall in supply has a similar but opposite effect.

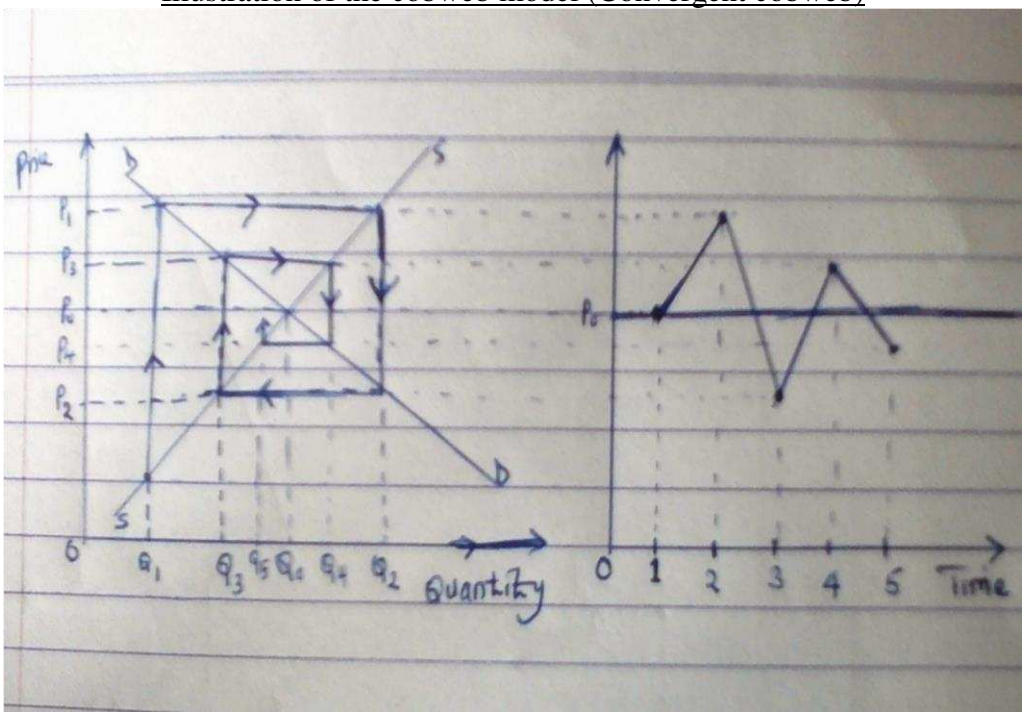
THE COBWEB THEORY

The cobweb theory is an economic model that attempts to explain the occurrence of price fluctuations in certain types of markets.

The cobweb theory is based on a time lag between supply and demand decisions. Since agricultural marketsare characterised by a time lag between planting and harvesting, the cobweb model can be applied to explain the occurrences of agricultural price fluctuations.

Because of this time lag, the output produced in a particular season is determined by the prices of the previous season.

Illustration of the cobweb model (Convergent cobweb)

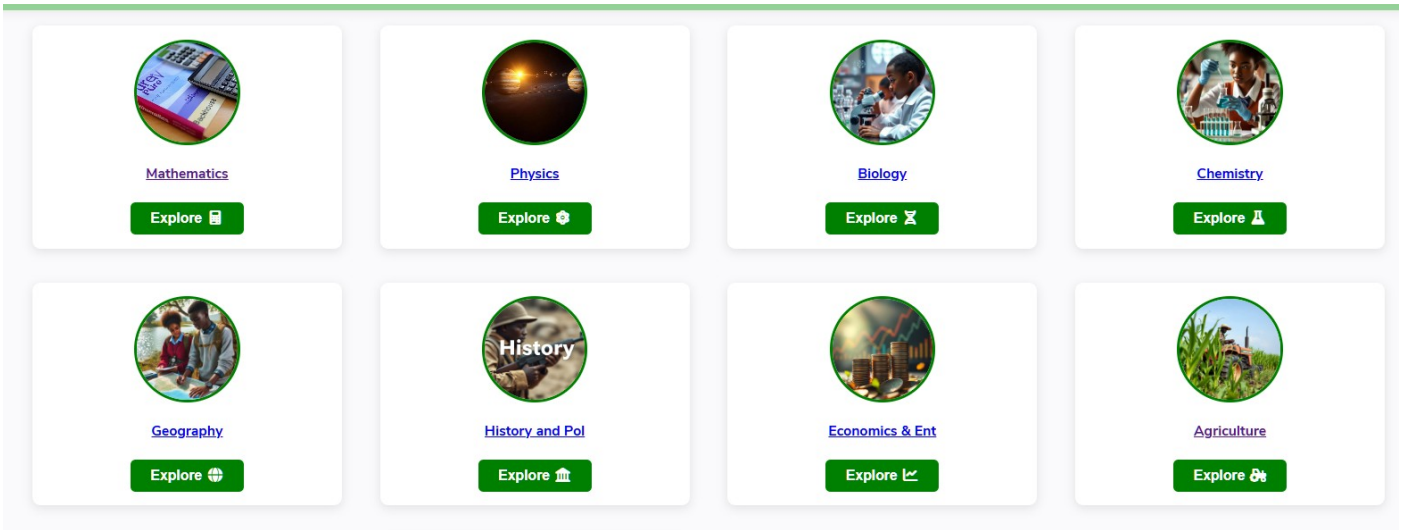


From the above illustration, initially the equilibrium quantity supplied is OQoand the equilibrium price is OPo.

Assuming there is a shock in an economy for instance an unexpectedly bad weather, this will result in a fall in the amount of the commodity supplied on the market from OQo to OQ1 (A shortage is created). This results into an increase in the price of the commodity from OPo to OP1. This increase in the price above equilibrium attracts new farmers to plant the same crop and also makes the old farmers to plant more. Because of the time lag between planting and harvesting, much will be supplied in the next season i.e. output increases from OQ1 to Q2 (There is surplus output). This forces the farmers to reduce the prices of their products from OP1 to OP2. This fall in price discourages some farmers and they stop growing the crop and even those who remain in production end up planting less. This results into less output put on the market the next season (Quantity OQ3 is supplied which is less than demand) again forcing prices to rise from OP2 to OP3. This process will go on until equilibrium is reached after a number of oscillations.

From the illustration, it can be observed that the fluctuations spiral inwardly meaning that the forces of demand and supply work out to restore the equilibrium conditions. This is a case where demand is more elastic than supply (The supply curve is steeper than the demand cury

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