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EASTERN CAPE
EDUCATION

GEOGRAPHY

AUTUMN CLASSES

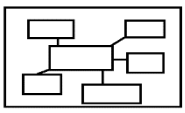
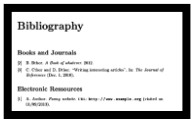
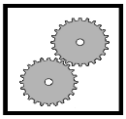
GRADE 12

TERM 1

TEACHER AND LEARNER CONTENT MANUAL

ICON DESCRIPTION

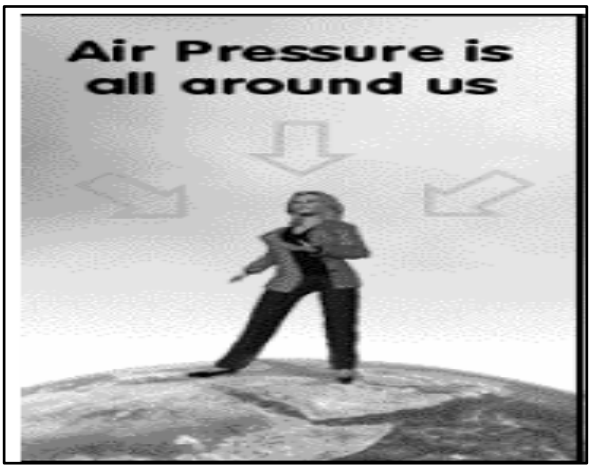
CONTENTS **PAGE**

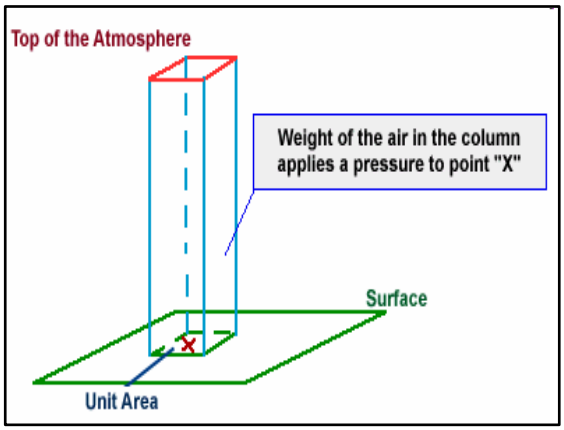
 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS

Air/Atmospheric Pressure

What is air pressure?

- Air pressure is the force exerted by the weight of a column of air above a particular location.





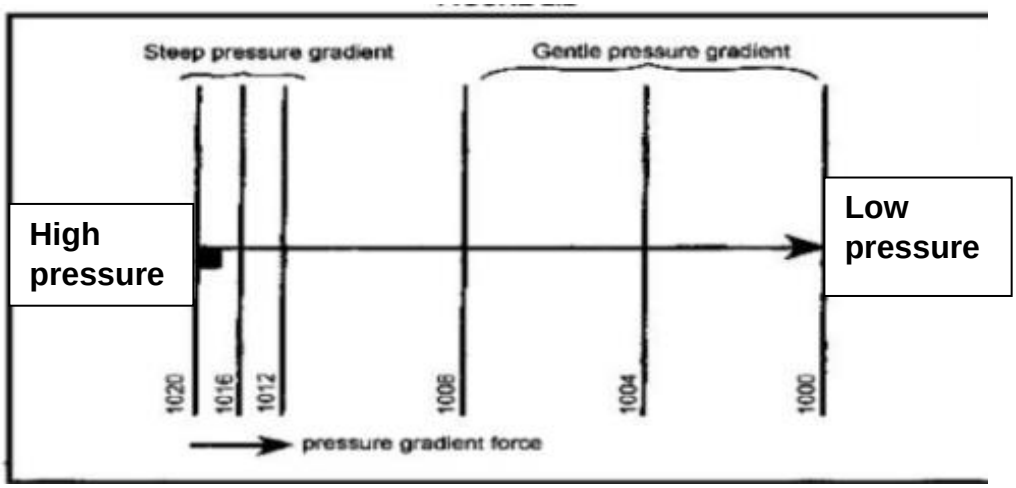
What causes pressure differences in the atmosphere?

The heating effect of the sun

- The warming effect of the sun varies with latitude and with the time of day.
- **Warmer air is less dense than cooler air, and rises above it,** so the pressure above the equator is lower than the pressure above the poles.

Pressure Gradient Force

- The difference in pressure between two points.
- Pressure gradient force is ALWAYS directed from high pressure to low pressure.

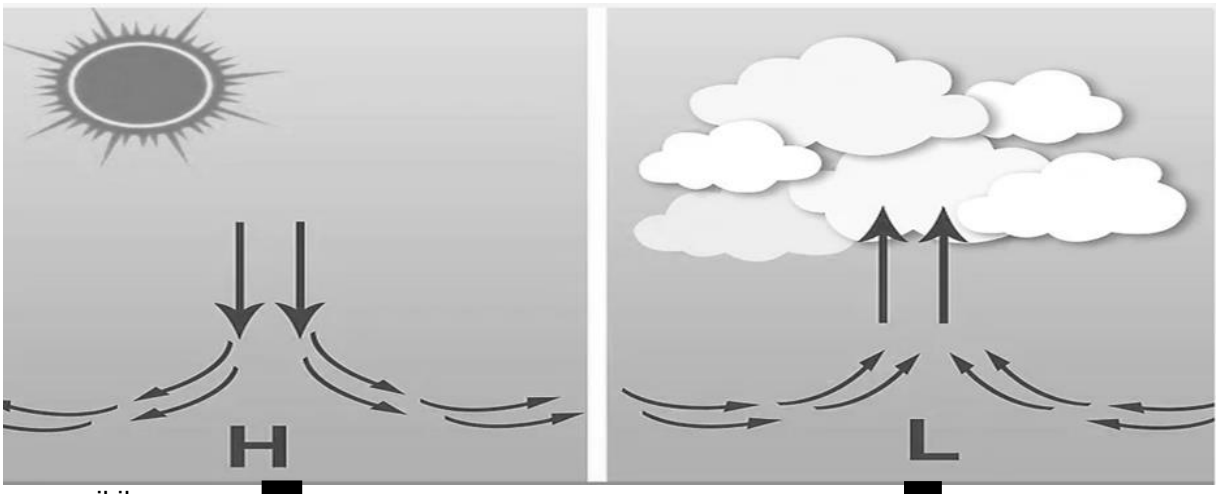


Wind

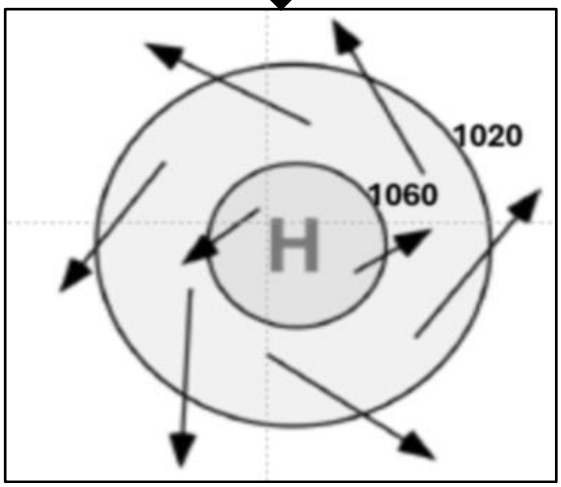
- Wind is the movement of air.
- Wind is the movement of air.
- This movement is caused by pressure differences, which in turn were caused by temperature differences.

Air movement or wind is due to pressure gradients(difference in air pressure) from place to place balancing out the pressure

Low pressure cell and High-pressure cell.

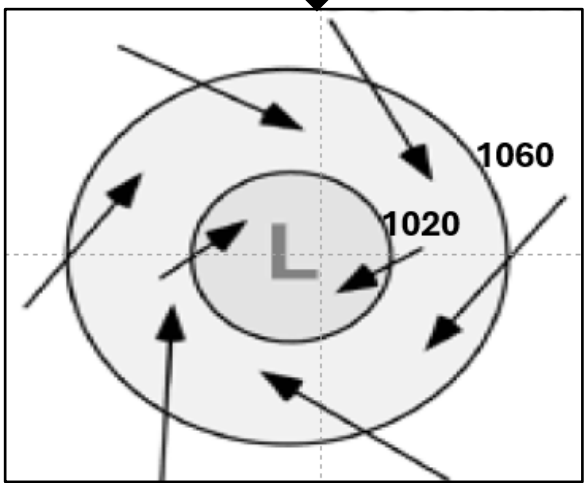


www.wikihow.com



High pressure cell in the Southern hemispheres

- an air mass that contains denser air
- cooler and/or dryer than the surrounding air.
- heavier air falls downward and away from the pressure system's center.
- With high pressure systems, the weather will tend to become clear or clearing.



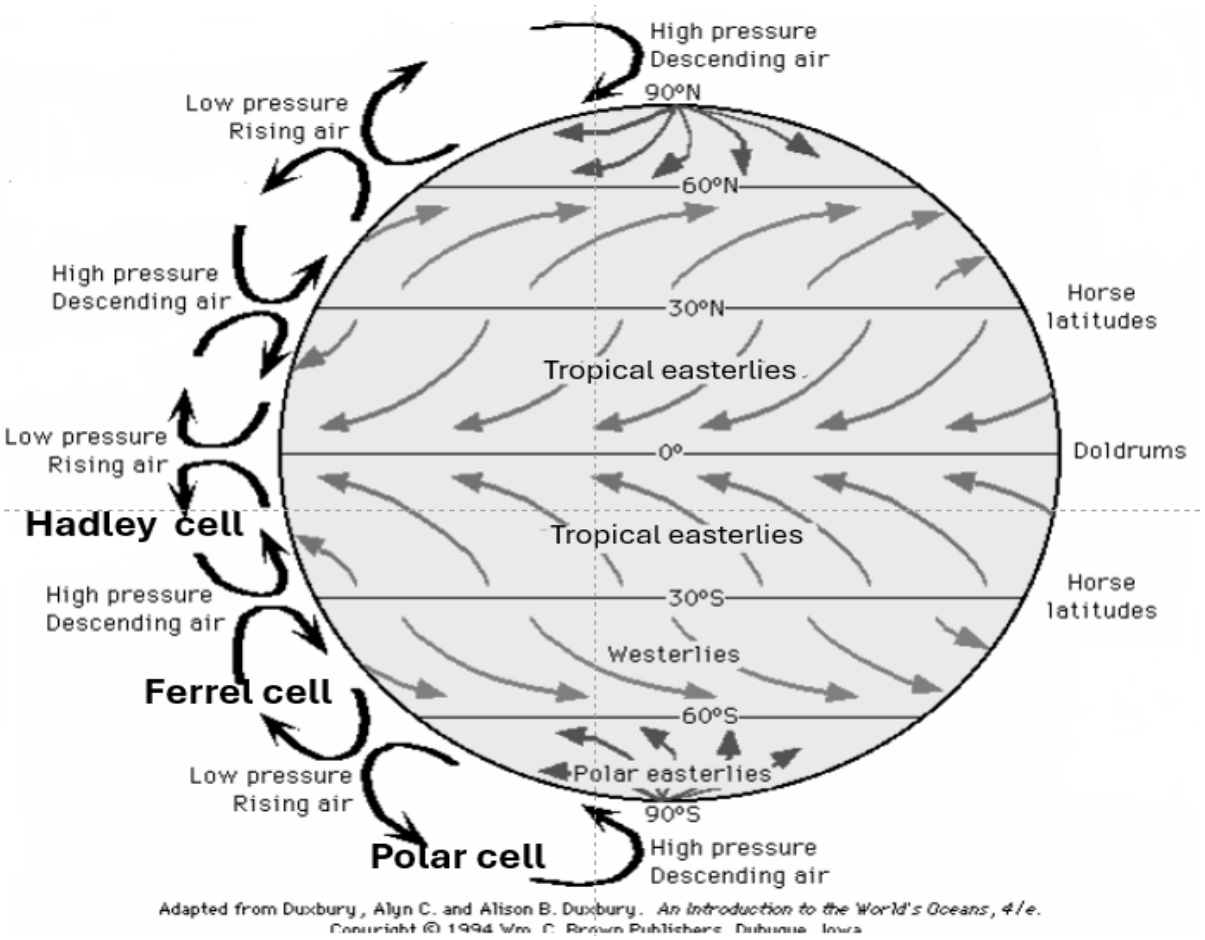
Low pressure cell in the Southern hemisphere

- an air mass that has less dense air
- air is moister and/or warmer. humid air and in some cases, precipitation.
- Surrounding air draws inward toward the low system's center
- lighter air balloons upward,
- causes clouds or precipitation because that moist air cools as it rises.

1.1 Mid-latitude cyclones (frontal depressions, extra-tropical cyclones)

- General characteristics
- Areas of formation

GLOBAL AIR CIRCULATION



Adapted from Duxbury, Alyn C. and Alison B. Duxbury. *An Introduction to the World's Oceans, 4/e.*
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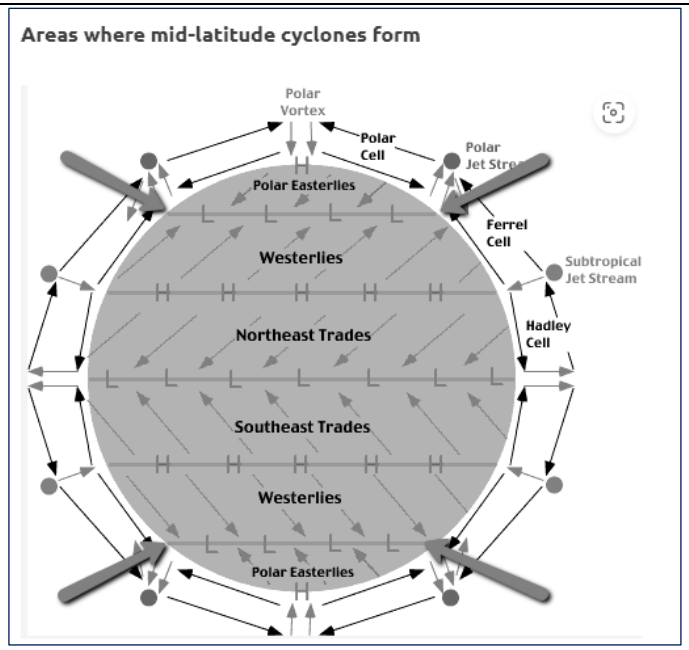
IMPORTANT TERMS AND DEFINITIONS

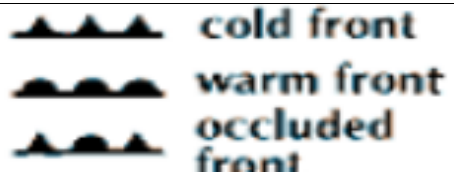
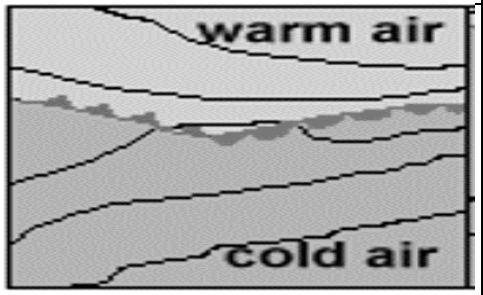
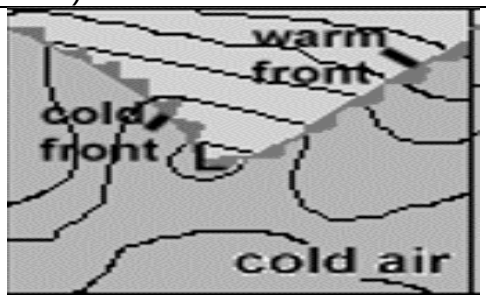
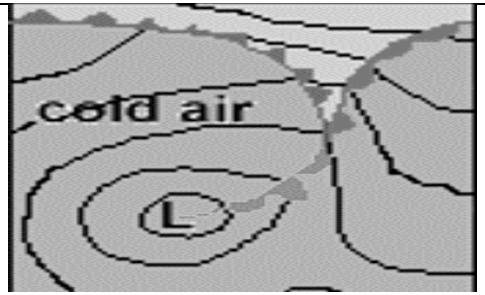
- Associated weather patterns
- pre-ca
- cyclone
- in

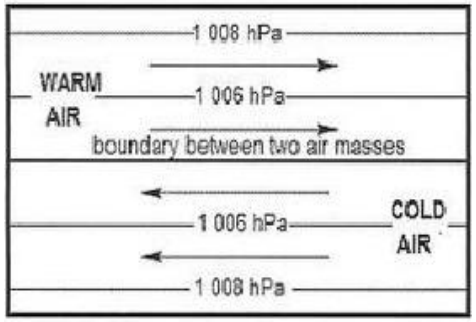
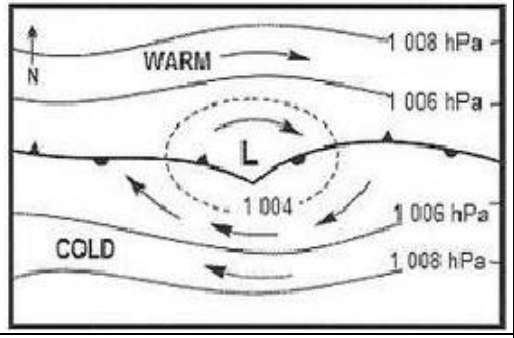
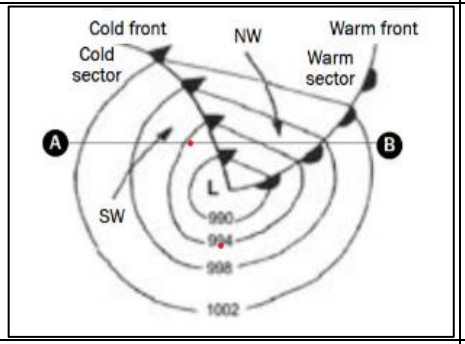
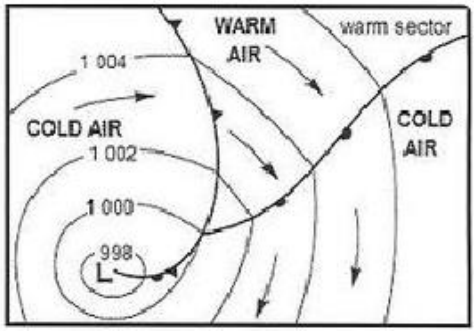
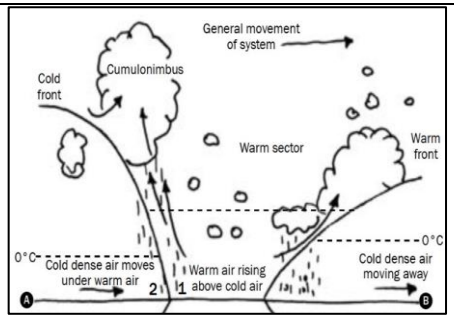
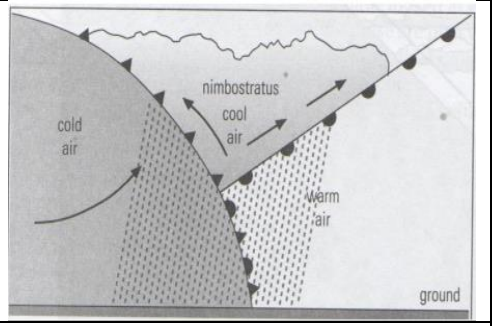
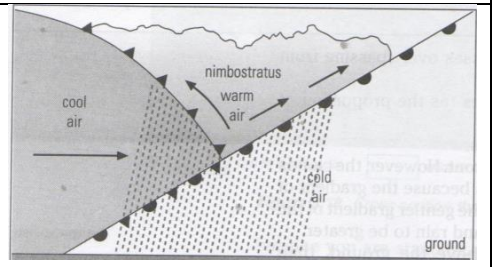
Cyclogenesis	development and strengthening of **extratropical(midlatitude)** cyclones.
Midlatitude cyclones	low pressure systems that have **cyclonic (clockwise)** flow in the southern hemisphere found in the **middle latitudes (mid latitude)** 30 ° and 60° South.
Front	a **zone of separation** between two air masses of different density and temperature.
Cold front	A cold front is the **boundary line** or the **leading edge** of a cooler mass of air that replaces a warmer mass of air at ground level. The air **behind** a cold front is **cool** and the air **ahead** of a cold front is **warm**.

Warm front	A warm front is the boundary line between a mass of warm air and a retreating mass of cold air. The air **behind** a warm front is **warm** and the air **ahead** of a warm front is **cold**.
Occluded front	a front formed when a cold front overtakes a warm front and forces it to rise.
Polar front	the transition region **separating warmer tropical air** from **colder polar air** in the mid-latitudes.
Wind shear	change in wind speed or direction.
Backing	Change of wind direction to the **left.** (anticlockwise) A backing wind would change from a **northerly wind** to a **north westerly** wind.
Veering	Changes of wind direction to the **right** (clockwise) A veering wind would change from a **northerly wind** to a **north easterly** wind.
Physical Environment	the part of the human environment that includes purely physical factors (as **soil, climate, water supply**).

1.1.2

Conditions necessary for formation	Areas of formation	General characteristics.
• **Frictional drag** caused by difference in temperature and speed of the two air masses.	• Occur in the middle latitudes of the earth, usually between 30° and 60° latitude north and south of the equator.	• They are sometimes called temperate cyclones, extra-tropical cyclones, midlatitude cyclones, frontal depressions or wave cyclones.
• Air masses must move opposite to each other and parallel.	• Cold polar easterlies **converge** with warm westerlies and move parallel but do not mix.	• They occur as a pair of fronts: a **warm front** and a **cold front** linked to a central area of low pressure.
• Warm subtropical air must meet cold polar air at the polar front.	 sageography.co.za	• The cold fronts reach South Africa mostly in winter. • The pressure belts and wind systems move slightly north in winter.
• There needs to be a large temperature difference between polar easterlies and subtropical westerlies for fronts to develop.		• They move from **west to east.** • They are steered by the **westerlies.** • Midlatitude cyclones move in an **easterly** direction. (**They move eastwards**)
• There must be a disturbance at the jet stream that will cause cold air to push into warmer air.		• The air rotates clockwise around a center of low pressure in the southern hemisphere.
• The warmer air will push up above the cold air mass creating a low-pressure cell into which the wind spirals.		• They have a large diameter, can stretch to about 2000km across. • They occur in families

	7 to 8 DAYS			
	Initial stage	**Mature stage**	**Occluded stage**	**Degeneration stage**
	Cold polar air and warm tropical air move parallel to each other but in opposite directions at the polar front.	Wave deepens and pressure gradient increases.	Cold front catches up to the warm front at the **apex**. **apex** is the shortest distance between the fronts.	All warm air is lifted off the ground and the cyclone weakens.
	Frictional drag takes place. Warm air becomes uplifted.	Cold and warm sectors fully developed. Both fronts fully developed.	Cold sector wedges below warm sector and warm sector narrows.	Air is cold and gusty as the sky clears.
	Fronts begin to form as air converges to the center low pressure	Warm air moves up steep pressure gradient of cold front to form towering cumulonimbus clouds. (Heavy rain and strong winds)	Two fronts combine to form an occluded front.	**Cold front occlusion:** warm air moves up the cold front. (cold front on the ground)
		Warm air moves up gentle pressure gradient of warm front to form a broad band of stratus clouds. (light rain over a large area)	Nimbostratus and rain.	**Warm front occlusion**: cold air moves up the warm front. (warm front on the ground)
				

	Stages of development			
	Initial stage	**Wave stage**	**Mature stage**	**Occluded stage**
	Plan view	Plan view	Plan view	Plan view
				
			Cross Section	**Cross Section**
				Cold front occlusion
	1. Initial stage The two air masses past one another and the do not mix They are separated by s stationery boundary known as a polar front. 2. Wave stage A wave can be caused by one or more of the following: a. Increase in one of the air masses b. Shape of the coastline c. Mountains 3. Mature stage Cold and warm fronts fronts are well developed well developed cold and warm sectors the pressure at the center is below 1000hpa 4. Occlusion stage Cold fronts travels faster than the warm front Warm sector narrows down Pressure increases on the ground. Cold front catches up with the warm front			
				Warm front occlusion
				

1.1.3 CROSS SECTIONS AND PLANE VIEWS THROUGH DIFFETENT STAGES OF A MIDLATITUDE CYCLONE

MATURE STAGE

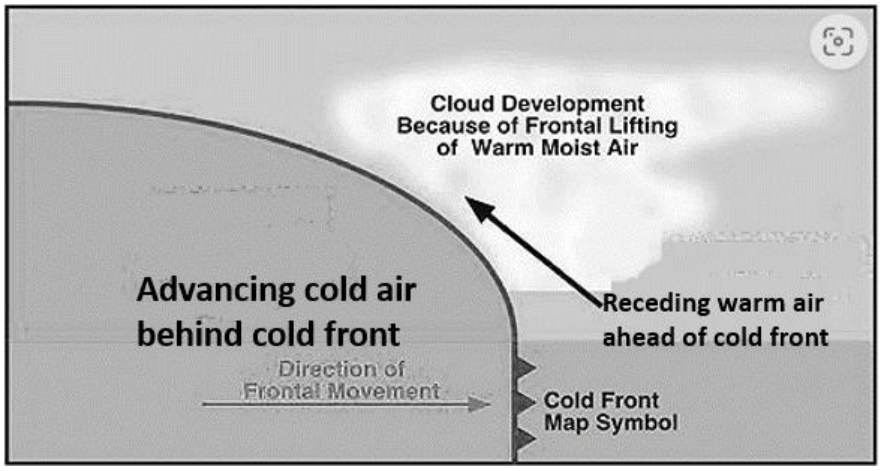
COLD FRONT OCCLUSION

Conditions

Temperature in front of system is higher than behind system

Cold front cuts into warm fr

COLD FRONT



Cold Front Conditions

Temperature decreases

Pressure decrease but increase with cold sector.

Humidity decreases

Cloud cover increases- Cumulonimbus clouds

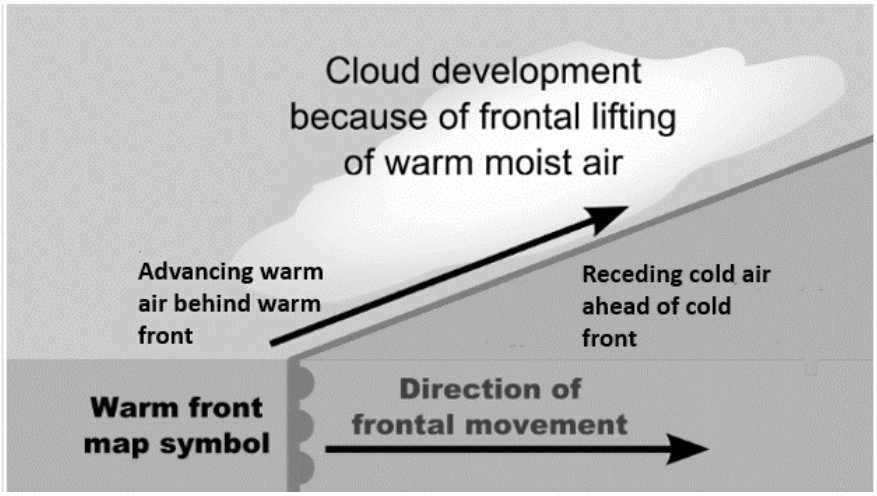
Chances of precipitation increase.

Heavy rain/ snow

Wind direction changes

Strong winds

WARM FRONT



Warm front conditions

Temperature increases

Pressure increases

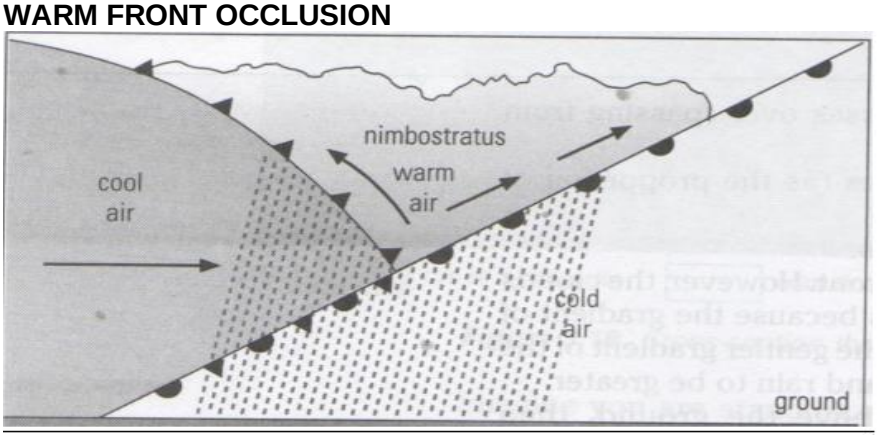
Humidity increases

Cloud cover- Nimbostratus

Precipitation: soft soaking rainfalls

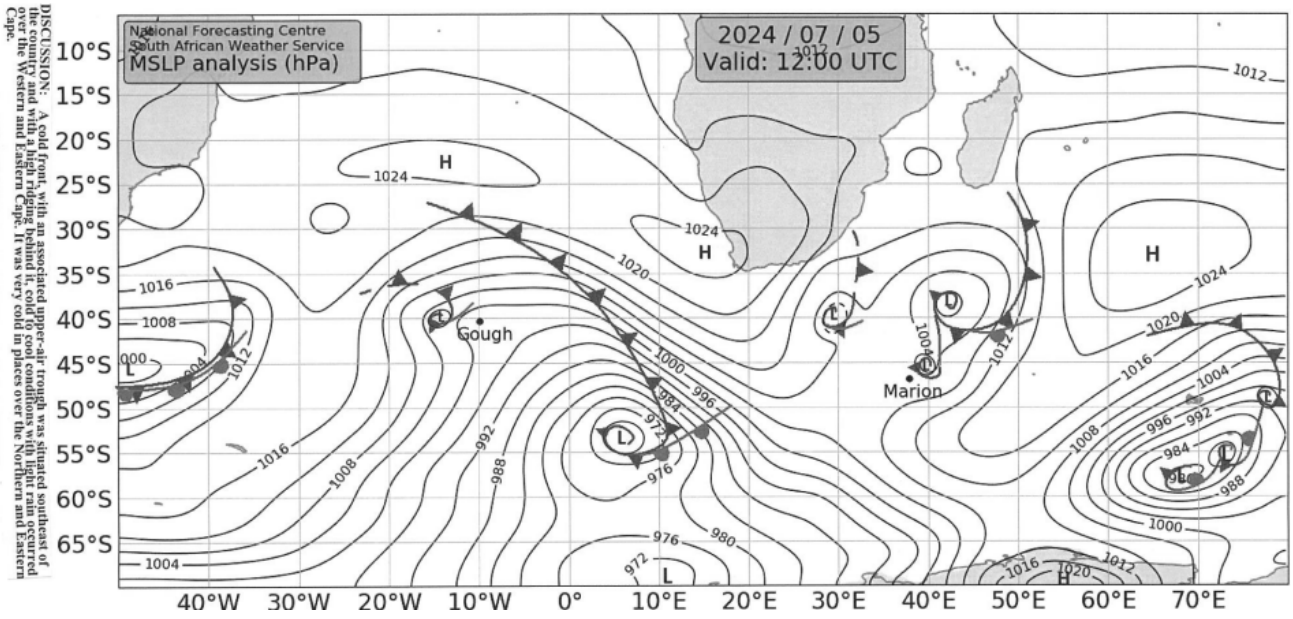
1.1.4 Impact of midlatitude cyclones human activities (social and economic) and the (physical) environment.

WARM FRONT OCCLUSION



Conditions
Temperature in front of system is lower than behind system
Warm front cuts into cold front

MIDLTIDUDE CYCLONES ON A SYNOPTIC MAP



Human activities

- Cyclones can trigger disasters, including the lives of people and property.
- Cyclone-induced storms can cause inland flooding.
- The torrential rainfall resulting from the Cyclone can cause extensive flooding and cover the whole range of human habitats
- Can wash away all the pesticides and fertilizers used by the farmers in their fields.
- Such activity can lose agricultural production and may result in food scarcity
- It affects the human settlements near the coastal areas causing significant property damage and human lives.

Environment

- The high onshore winds can drive sea-level rise to large meters, reaching unusual heights
- A cyclone extends damage on the waves basically on the beach, eroding.
- It may cause coastal flooding.

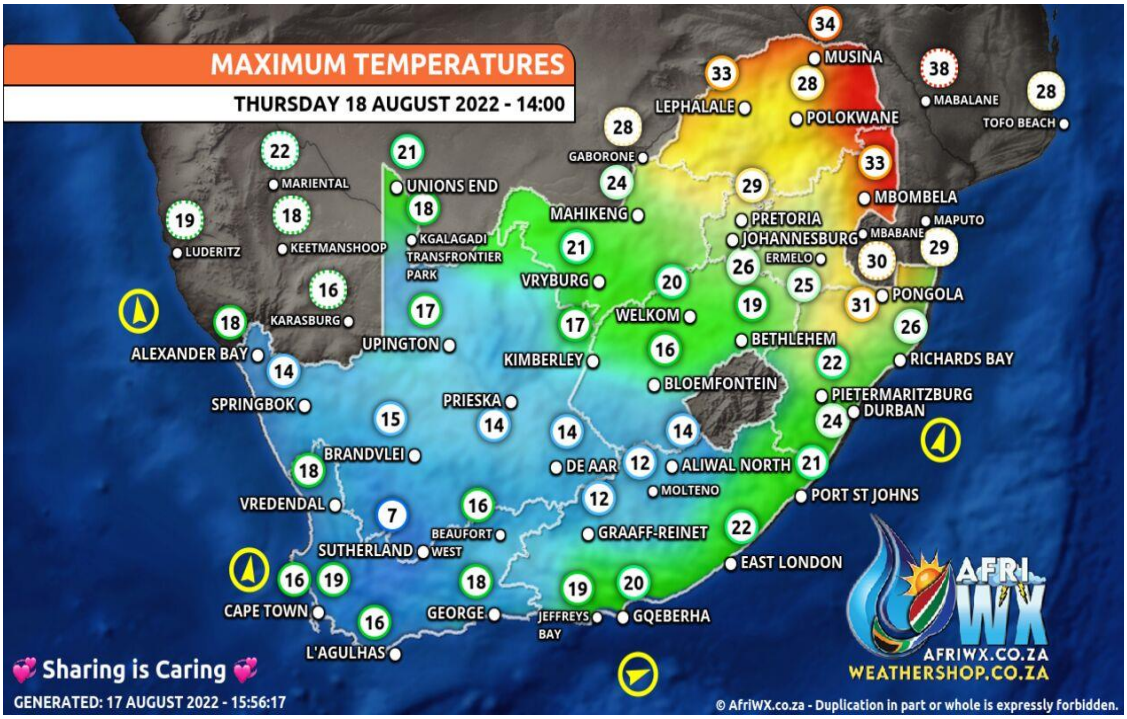

Possible pre-cautionary and management strategies

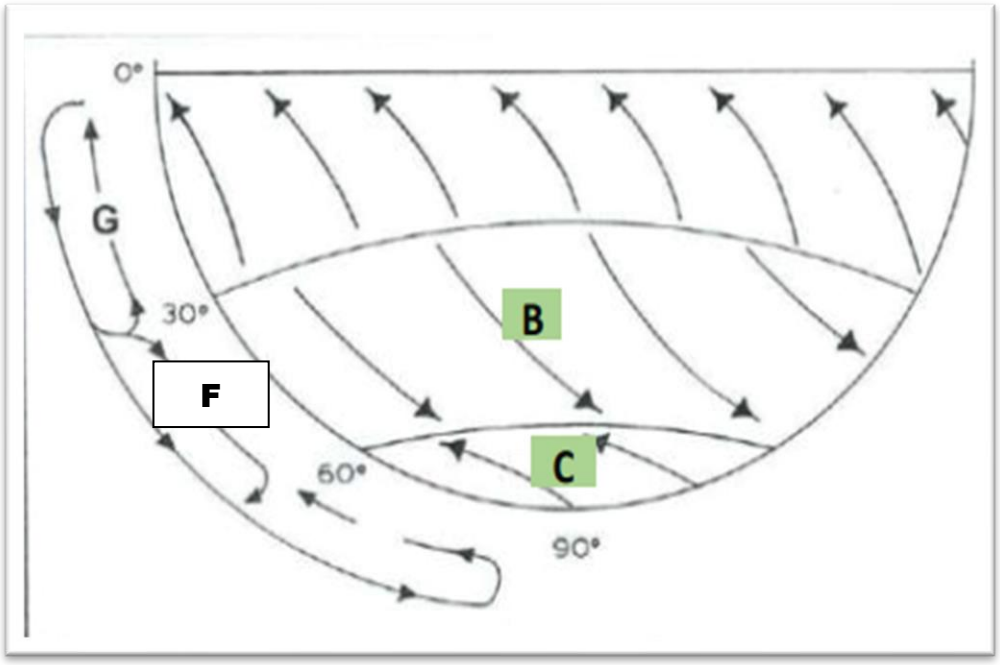
- Monitoring the development of Mid-Latitude cyclones.
- Early warning systems for people to be prepared.

- Evacuate low lying areas to protect it against floods
- Keep livestock in barns to protect them against the cold.
- Plant winter crops that can resist cold
- People should stay indoors for protection against the cold, wind, and rain

ACTIVITY 1 **30 minutes**

1.1 Refer to sketch below

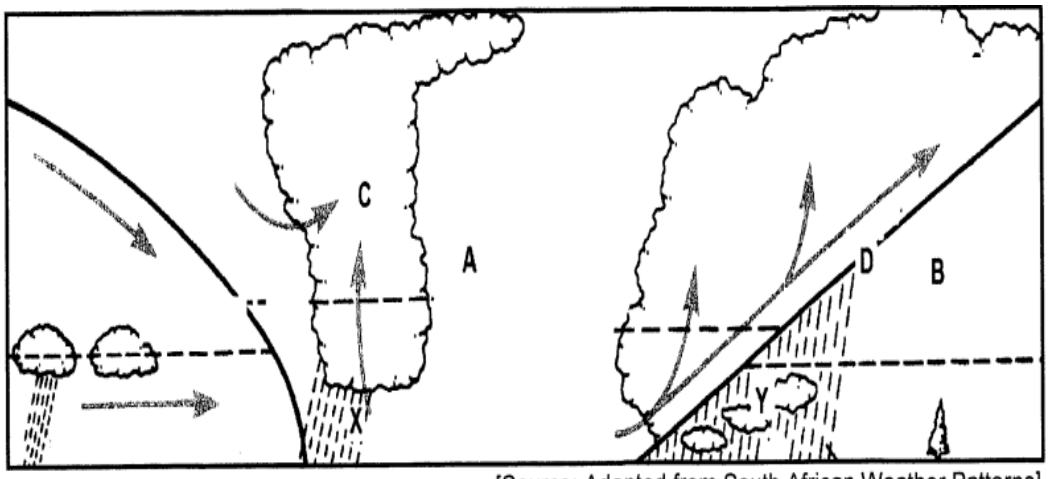




1.1.1	Identify the planetary winds labelled **B** and **C**	(2x1)	(2)
1.1.2	Identify the zone where planetary winds **B** and **C** converge	(1x2)	(2)
1.1.3	How is the temperature for winds **B** and **C** respectively?	(2x1)	(2)
1.1.4	Name the winds at **F** and **G** that develops that develops between 0° and 30°.	(2x1)	(2)
1.1.5	An area near the Equator where the winds die out is called	(1x1)	(1)
1.1.6	The winds that are associated with the ITCZ are called	(1x1)	(1)
1.1.7	A force that influences the speed of winds	(1x1)	(1)
			(10)

ACTIVITY 2

2.1 Midlatitude cyclone



[Source: Adapted from South African Weather Patterns]

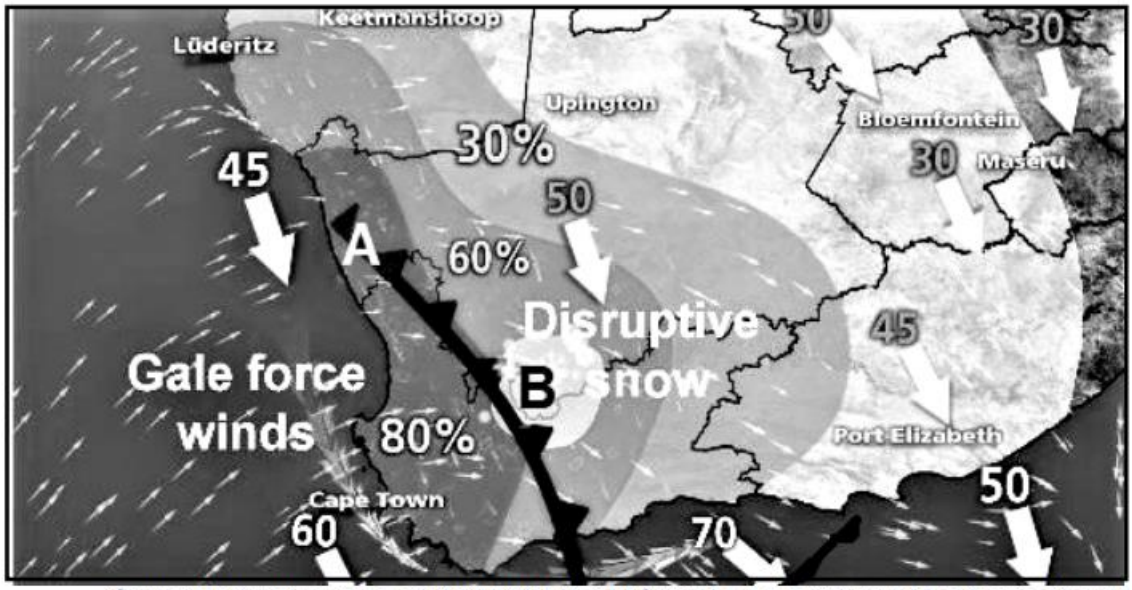
2.1.1	Identify the stage of development of a midlatitude cyclone in the sketch above.	(1x1)	(1)
2.1.2	Which wind is responsible for the direction of movement of this system?	(1x2)	(2)
2.1.3	Identify areas **A** and **B** of a midlatitude cyclone.	(2x1)	(2)
2.1.4	Explain the conditions that led to the formation of the cloud type at **C.**	(2x2)	(4)
2.1.5	Discuss the negative impact of the type of rainfall at **X** on the natural environment.	(3x2)	(6)
			15

ACTIVITY 3

WARNING OF SEVERE WEATHER

Cape Town - Batten down the hatches. Heavy rain, cold winds, severe flooding and even light snow are predicted as a battery of cold fronts head for the Western Cape that could bring discomfort and displacement in some areas. The South African Weather Service (SAWS) said this might cause thunderstorms, flooding of roads in both formal and informal settlements, damage to property and infrastructure, loss of livelihoods and livestock, damage to crops, disruption to essential services, and disruptions of traffic flow due to roads being flooded or even closed.

[Source: https://www.iol.co.za/capeargus/news/warning-of-high-impact-cold-fronts-as-rain-winds-and-snow-predicted-for-western-cape-4cceba02-eaa1-494a-804b-80ccc1f2157f]



[Source:https://ewn.co.za/2022/06/14/cold-front-to-be-expected-in-johannesburg]

3.1.1 Identify the weather system shown in the diagram, of which the cold front forms a part. (1x1) (1)

3.1.2 What is the main reason why these weather systems are more prevalent (common) over Cape Town during winter, as shown in the article? (2x2) (4)

3.1.3 Draw a labelled, free-hand cross section through the cold front indicated as **A** in the diagram.
Indicate the weather elements preceding the cold front on the cross-section diagram. (4x1) (4)

3.1.4 Explain how the weather system identified in QUESTION 3.1.1 resulted in the development of clouds at **B** (1x1) (2)

3.1.5 Predict the impact of the weather elements of this weather system on farming as it passes over the Western Cape. (2x2) (4)

(15)

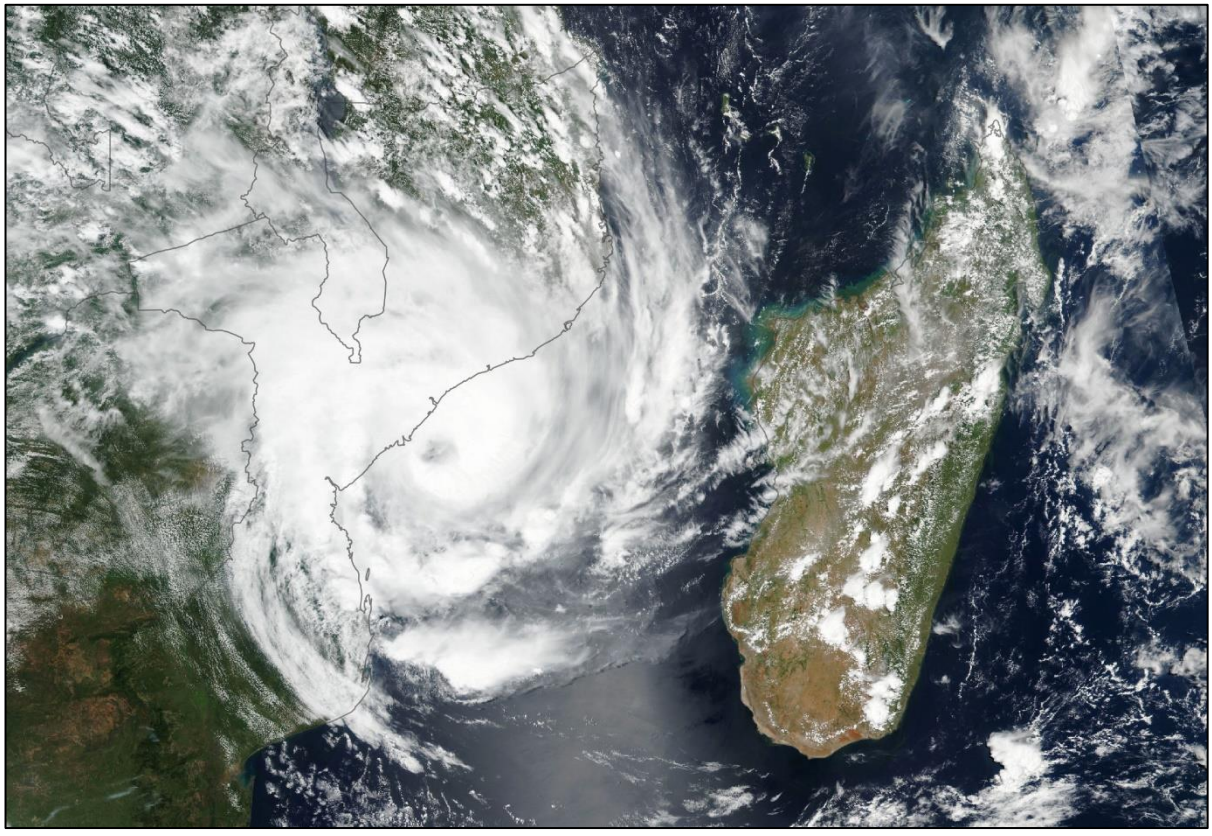
Tropical cyclones

- General characteristics
- Areas of formation and associated terms in different parts of the world
- Factors necessary for the formation

- Stages of development
- Associated weather patterns
- Cross-section through a tropical cyclone (interpretation)

- Impact on human activities (social and economic) and the environment (the impact of the weather associated with tropical cyclones)
- Pre-cautionary and management strategies to manage the effects of tropical cyclones.
- Identification on synoptic weather maps and satellite images:
- Identification of stages of development on synoptic weather maps Reading and interpretation of applicable weather symbols
- Case study of ONE recent tropical cyclone

Tropical cyclone Eloise January 22, 2021



IMPORTANT TERMS AND DEFINITIONS

Tropical Cyclone	A powerful, rotating storm system, around a low-pressure cell which develops over a warm ocean between the tropics.
Coriolis force	A force caused by the rotation of the earth which results in the deflection of the winds and ocean currents.
Eye	The calm area at the centre of a tropical cyclone
Eyewall	The walls of cumulonimbus cloud which surround the eye of a tropical cyclone.
Latent heat	The heat or energy that is released during condensation.
Stormsurge	Abnormal rise of water along the coast associated with a low pressure system as a tropical cyclone
Vortex	A mass of spinning air that attracts more air to its centre.
Waterspout	It is a weak tornado that forms at sea in association with the storm clouds of a tropical cyclone.

1.2.1

Factors necessary for the formation

The formation of tropical cyclones is strongly influenced by the temperature of the underlying ocean.

A sea temperature of 27° C.

Strong Coriolis Force.

Strong upper air divergence.

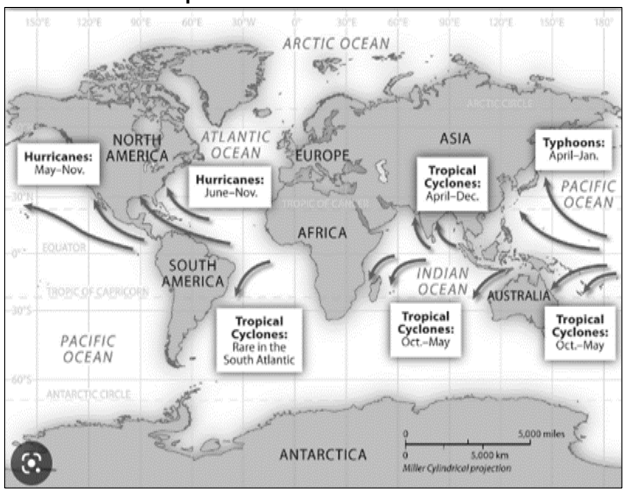
The hot air starts rising and forms an intense low pressure on the surface
The tropical jet stream in the upper air causes an upper air low pressure and this intensifies the low pressure on the surface.
Air is sucked into the low pressure.
Needs Coriolis forced to cause spiraling winds

Areas of formation and associated terms in different parts of the world

Tropical cyclones are also known as hurricanes in America; typhoons in China and Japan; and willy willies in Australia.

Over tropical oceans 5°–30° N and S.

Do not occur between 0° to 5° N and S. because Coriolis force in weak.
Cannot develop outside 30° N and S because temperatures are low.



General characteristics

They are given names alphabetically within the season in which they occurred. For example, ‘Alfred’ will denote that it is the first tropical cyclone to occur in that season.

Occur in Mid- to late summer, early autumn

Intense low-pressure system, below 1000 hPa.

Clockwise movement of air in Tropical Cyclone in the Southern Hemisphere.
Steep pressure gradient increases the wind speed.
Move from west to east within the tropical easterlies.

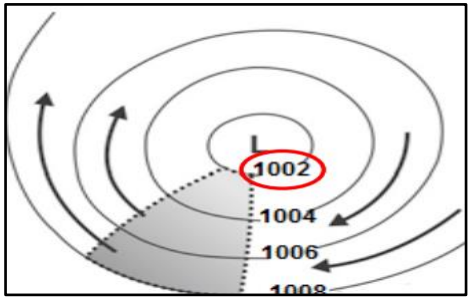
Winds up to 300km/h.

Eye develop in the centre of low pressure.
High Cumulonimbus clouds forms the eye wall.

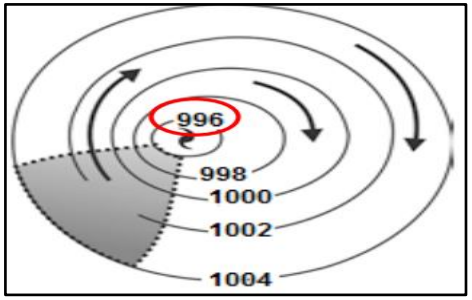
Heavy rainfall, hail, storm surges and hurricane winds
Affect the east coast of continents.

1.2.2 Stages of development

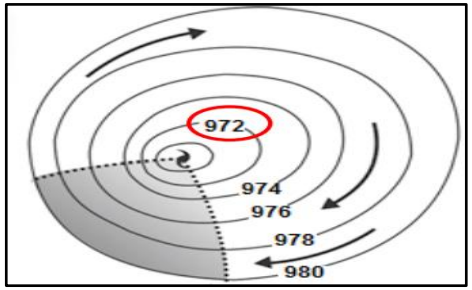
Formative	Immature	Mature	Dissipation
The cyclone has very strong up draughts and the low pressure intensifies.	Intensity of storm increases as air continue to coverge and rise in LP centre. Eye forms in centre of LP.	The pressure gradient is very strong and wind speeds reach hurricane strength. Fully developed eye.	When the tropical cyclone moves over land, the wind is slowed down by friction and there is less evaporation to cause unstable air conditions.
The cyclone is not very large yet and there is no clear eye yet.	Divergence takes place in upper atmosphere	The calm, clear eye is well developed and the air pressure is less than 950hPa.	The cyclone also moves into cooler sub-tropical areas and the air pressure increases.
The winds start spiraling	Air pressure drops below 990hPa Wind speed increases to about 120 km/h.	The South Western quadrant is the most destructive as the winds and the Tropical Easterly winds are coinciding.	The weather clears up
	Huge cumulonumbus clouds forms the eyewall around the eye.	The cyclone can cover distances of up to 300km from the eye. The cyclone moves in a South Westerly direction from the equator and then turns South East at about 20º South.	



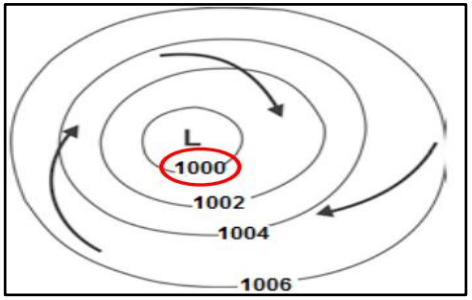
Pressure above 1000hpa



Pressure below 1000hpa

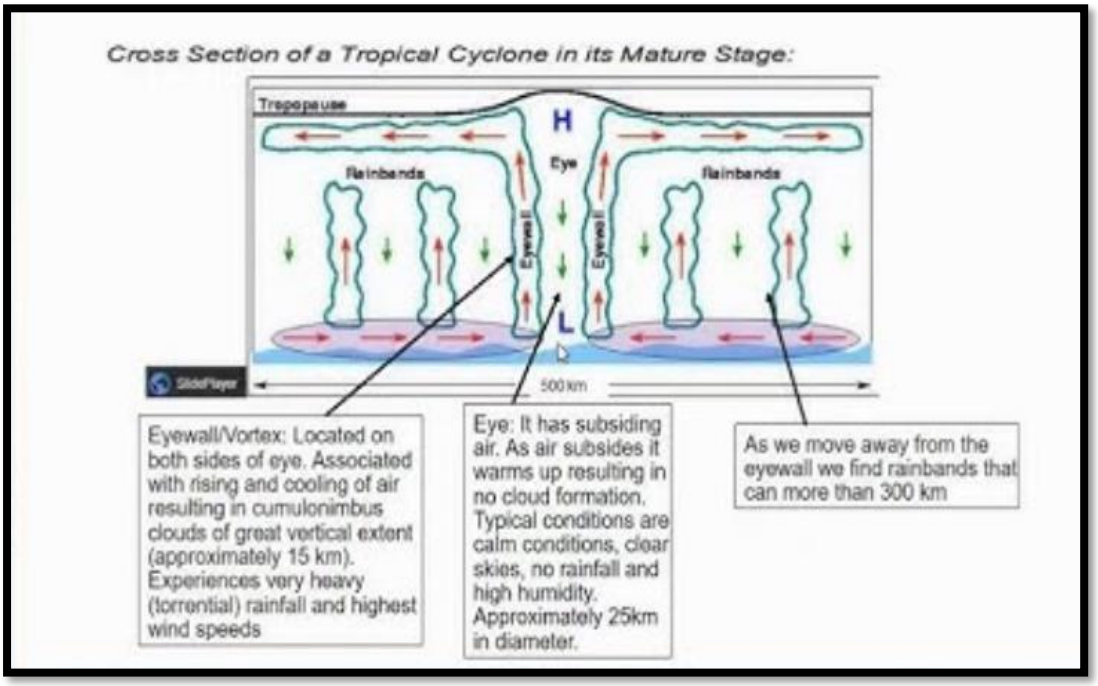


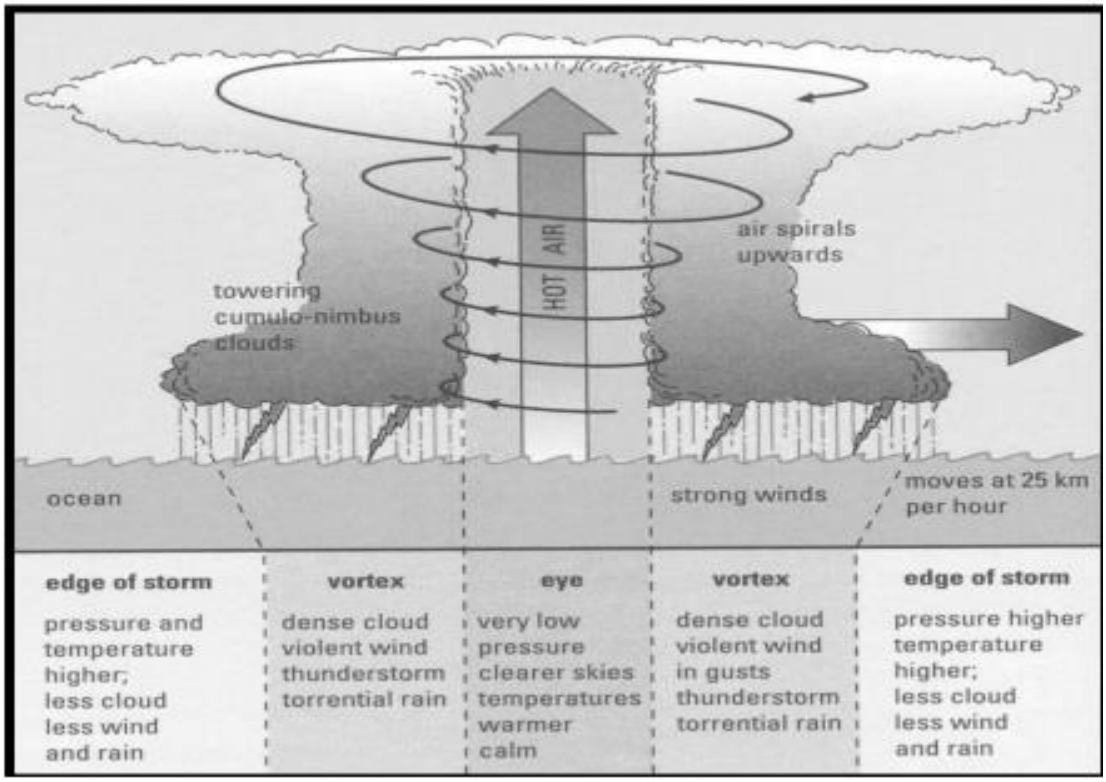
Pressure well below 1000hpa



Pressure rises

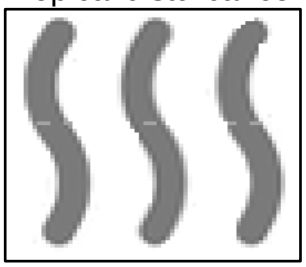
1.2.3 Cross-section through a tropical cyclone



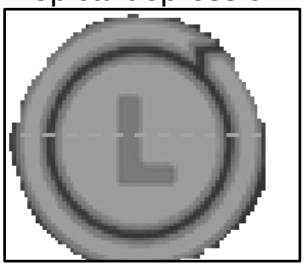


TROPICAL CYCLONE DEVELOPMENT

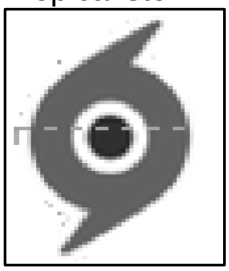
Tropical disturbance



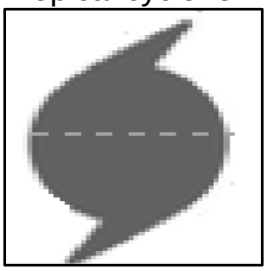
Tropical depression



Tropical storm



Tropical cyclone



Humans

Torrential rain results in the risk of flooding.
Strong winds damage and shatter windows and rip off roofs.
Storm surges cause damage to the coastal areas.
Damage infrastructure. Roads and bridges washed away.
Loss and damage of homes.
Damaged water pipes result in lack of fresh water.
Wind and water damage power lines.
Deaths and injuries of people and animals because of wind, floods and storm surges.
Starvation because of lack of food.
Outbreak of diseases e.g. cholera, typhoid etc.
Major financial strain on families.
Subsistence farmers lose everything.
Swell of waves is dangerous for fisherman/humans

Environment

Strong winds cause storm surges which can cause rapid rise in sea-levels.
Floods and salt water destroy agricultural crops.
Flooding and rise in river levels because of rain can cause mudslides and landslides.
Destroy ecosystems and biodiversity.
Livestock drowns./Lack of clean water.
Threatening of food security.
Damaged sewerage pipes result in pollution

Economy

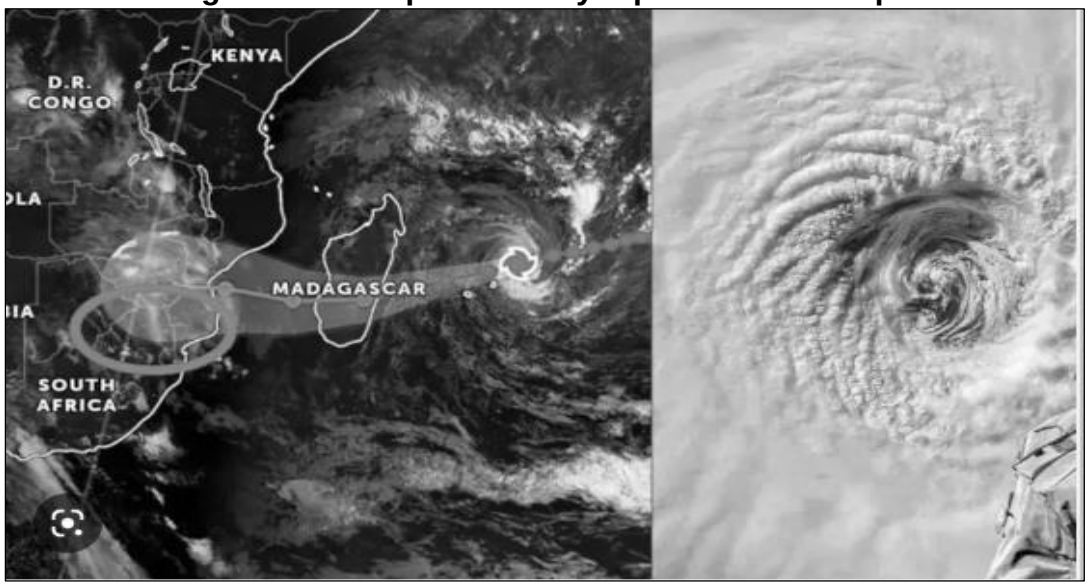
Airports are closed.
Damage harbor facilities.
Businesses are closed.
No trading is possible.
Costly to repair damages.
Job losses, unemployment
High medical expenses.
Costly insurance claims (business and personal).
Put a strain on local civic services.
Limits export. Increases imports (food and other commodities).

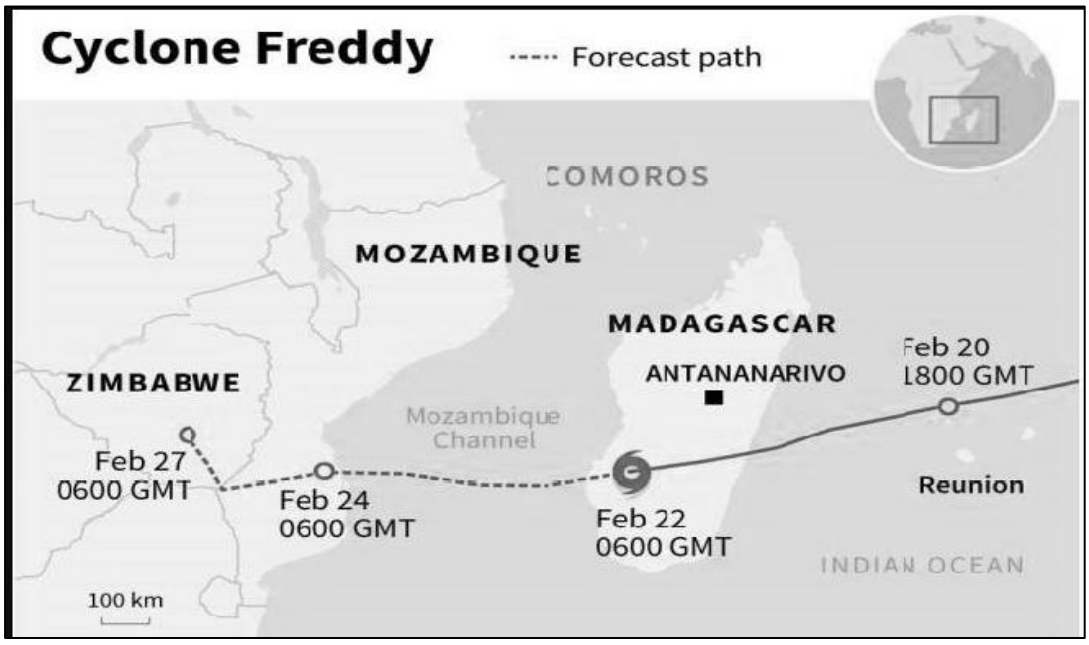
Pre-cautionary and management strategies to manage the effects of tropical cyclones

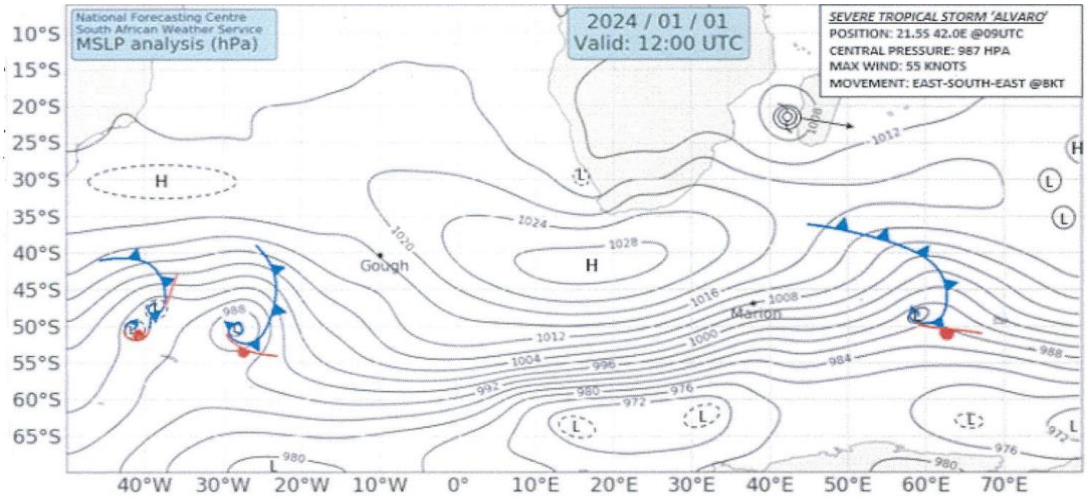
Monitoring the development of Tropical cyclones.
Satellite tracking can monitor the development and path.
Satellite censors to collect details e.g. rainfall rates.
Advanced weather predictions and warnings.
Early warning and communication for people to prepare.
Evacuate low lying areas to protect people against floods.
Ensure that infrastructure is of good quality.


UKaid

Identification of stages of development on synoptic weather maps







Activity 4

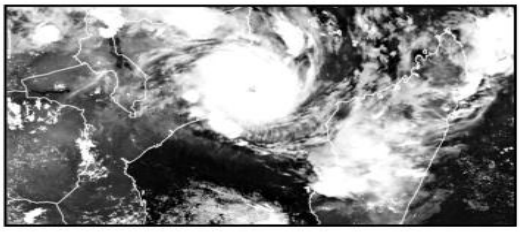
4.1 Tropical Cyclone Gombe

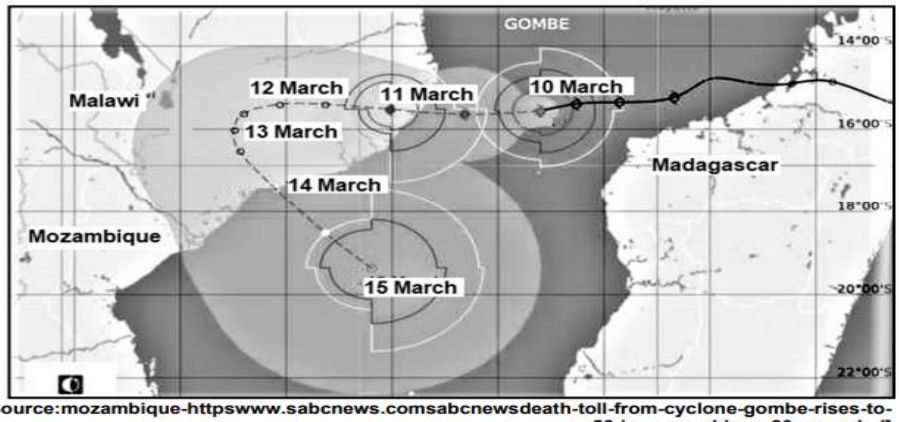
Mozambique: Cyclone Gombe

Tropical Cyclone Gombe has killed at least 53 people since the cyclone swept into northern and central areas of the country on Saturday, March 12, 2022. Data showed that the flooding associated with Gombe, destroyed a total of 141 854 houses along with 69 health centres, 21 water systems and 2 764 electricity poles. A total of 2 265 classrooms were damaged affecting a total of 216 003 pupils and 4 421 teachers. A total of 91 177 hectares of crops were lost while a total of 1 243 km of roads were severely damaged. Southern Africa has suffered repeated devastating cyclones of the type that used to be relatively rare in the past. Scientists believe climate change is fuelling their intensity via the warming of the Indian Ocean.

[Source:https://www.aljazeera.com/news/2022/3/18/mozambique-cyclone-gombe-death-toll-rises-to-53]

Satellite image of Tropical Cyclone Gombe





[Source:mozambique-httpswww.sabcnews.comsabcnewsdeath-toll-from-cyclone-gombe-rises-to-53-in-mozambique-80-wounded]

4.1.1 How many tropical cyclones have occurred before Tropical Cyclone Gombe? (1x1) (1)

4.1.2 According to the infographic, what is the scientific evidence fueling the intensity of tropical cyclones in the Indian Ocean? (2x1) (2)

4.1.3 Provide evidence from the satellite image which suggests that Tropical Cyclone Gombe has reached the stage of maturity (1x2) (2)

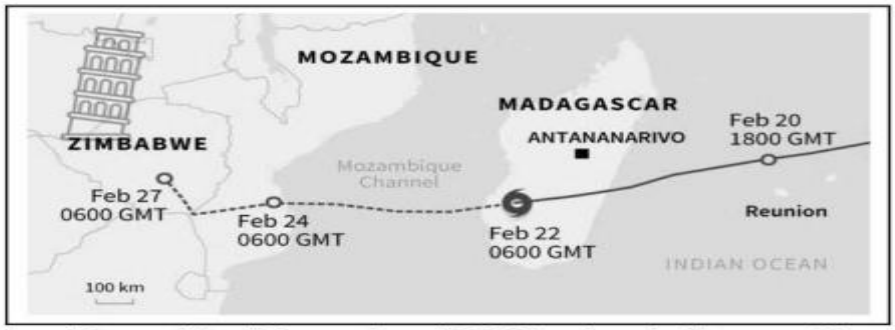
4.1.4 Discuss why Tropical Cyclone Gombe will decrease in intensity once it reaches the coastline of Mozambique. (2x2) (4)

4.1.5 Explain TWO weather elements of Tropical Cyclone Gombe, indicated in the infographic, that may have resulted in the damage caused to the infrastructure (2x2) (4)

4.1.6 Suggest TWO precautionary strategies that can be implemented in this area to reduce the possible damage caused to the infrastructure during tropical cyclones by flooding, as mentioned in the article. (2x2) (4)

(15)

Activity 5



[Source: https://phys.org/news/2023-02-cyclone-freddy-mozambique-madagascar.html]

[Source: https://www.news24.com/news24/africa/news/death-toll-from-cyclone-freddys-return-rises-to-8-in-madagascar-20230307]

CYCLONE FREDDY

ONE of the longest-lasting weather systems in the southern hemisphere, ex-tropical cyclone Freddy, is expected to bring heavy rain and a risk of flooding to Madagascar's western and southern parts from tomorrow (Friday) evening.

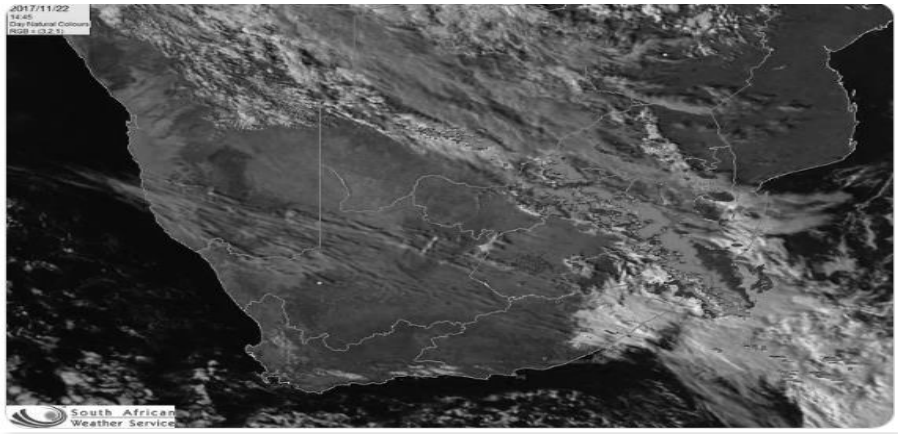
Freddy weakened from an intense category 4 equivalent into a category 3 cyclone ahead of landfall on the eastern Malagasy coast near the town of Mananjary during the evening of 21 February, with sustained wind speeds of 150 km/h. All eyes are once again on Freddy, currently classified as a tropical depression, as the system is expected to re-intensify in the Mozambique Channel.

[Source: adapted from OCHA SOUTHERN AFRICA: Tropical Cyclone Freddy Flash Update No. 4 01 March 2023]

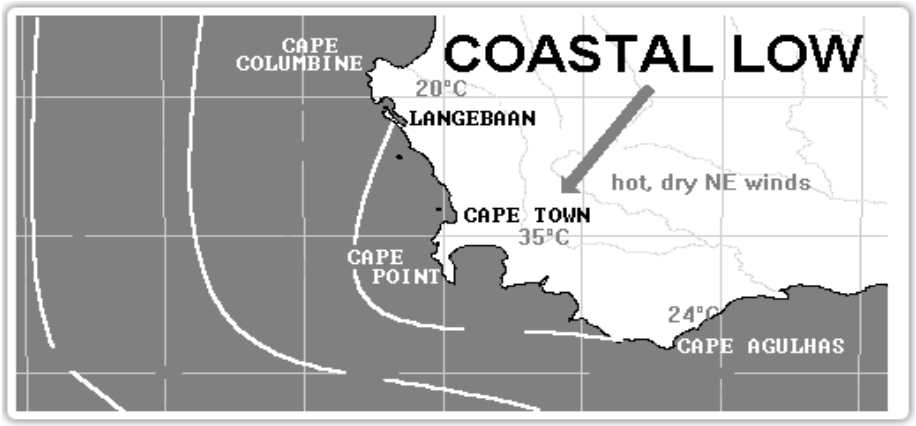
5.1.1	With reference to the infographic, identify the general direction in which Cyclone Freddy is moving	(1x1)	(1)
5.1.2	Account for the movement mentioned in QUESTION 5.1.1	(1x2)	(2)
5.1.3	Give evidence from the infographic that Cyclone Freddy was accompanied by hurricane force winds	(2x2)	(4)
5.1.4	According to the infographic the system is intensifying (getting stronger) in the Mozambique channel. Explain why the system is intensifying when in moves in the Mozambique Channel	(2x2)	(4)
5.1.5	Tropical cyclones can develop very quickly; therefore, a reliable early warning system is important. Suggest THREE early warning systems that the governments of Mozambique and Madagascar could have introduced to reduce the impact of Cyclone Freddy.	(3x2)	(6)
			(19)

1.3 DEVELOPMENT OF TRAVELLING DISTURBANCES ASSOCIATED WITH ANTICYCLONIC CIRCULATION
EXAMINATION GUIDELINES

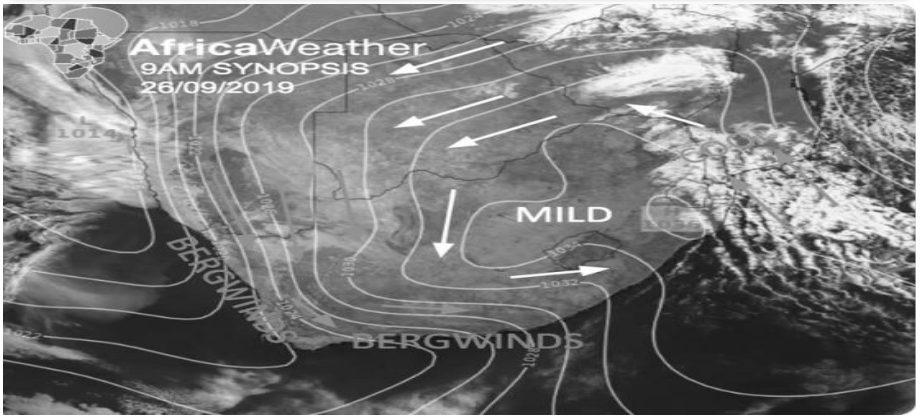
Moisture front and line thunderstorms
Coastal low pressure
South African berg wind
Resultant weather and impact (and strategies to reduce the impact) associated with moving disturbances
Identification of moving disturbances on synoptic weather maps and satellite images
Reading and interpretation of synoptic weather maps and satellite images that illustrate weather associated with anticyclonic conditions



Line thunderstorms



Coastal Low

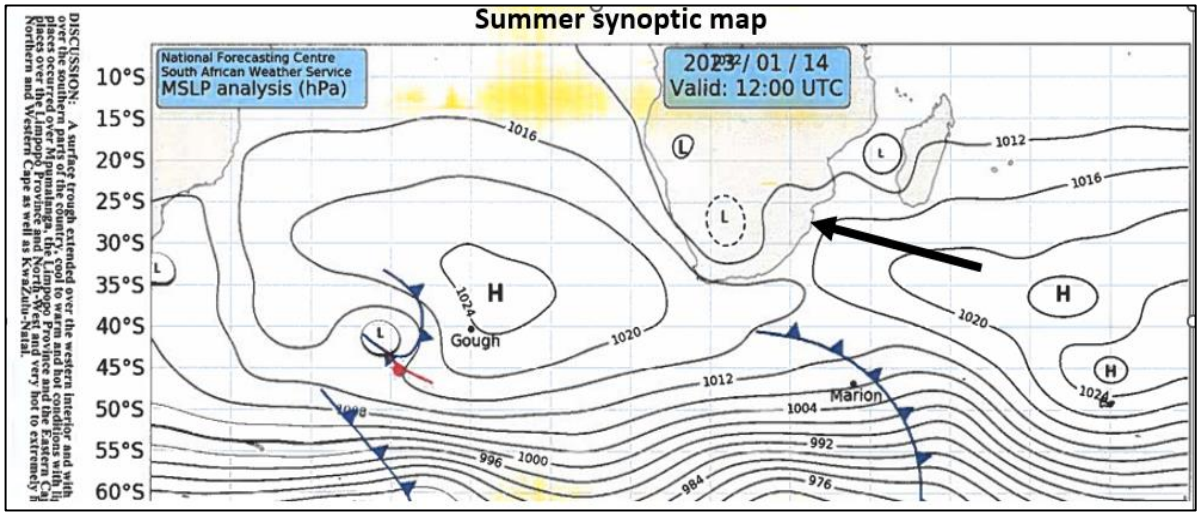


Berg Winds

IMPORTANT TERMS AND DEFINITIONS

Adiabatic heating	Heating which occurs when the air is compressed.
Berg wind	A local wind that blows down the escarpment from the plateau to the coast, bringing hot, dry weather.
Coastal low	A localised low-pressure system that brings changeable weather to a coastal region.
Cut-off low	A low-pressure cell which has become completely displaced over the land and moves independently of any air around it.
Line thunderstorm	Summer storms that occur when a trough of low pressure develops over the interior between the thermal low and coastal low.
Ridge	An extension of a high-pressure cell when the isobars extend along the east -west axis. This happens when the south Atlantic high sometimes extends behind a passing cold front in winter or around the southern tip of South Africa in summer.
Trough	Occurs between two low pressure cells or an extension of a low pressure cell.

Summer Weather Conditions:



- The Kalahari high pressure system lifts due to continental heating.
- This allows the moist tropical air masses to bring in humid air over the interior which causes summer rain over the interior
- The Indian Ocean and Atlantic Ocean high pressure systems are situated more southward of the country.
- A trough of low pressure is positioned over the central and eastern parts of the country with moisture being advected from the tropical Indian Ocean anticyclone which results in greater rainfall towards the eastern parts of the country and less towards the west

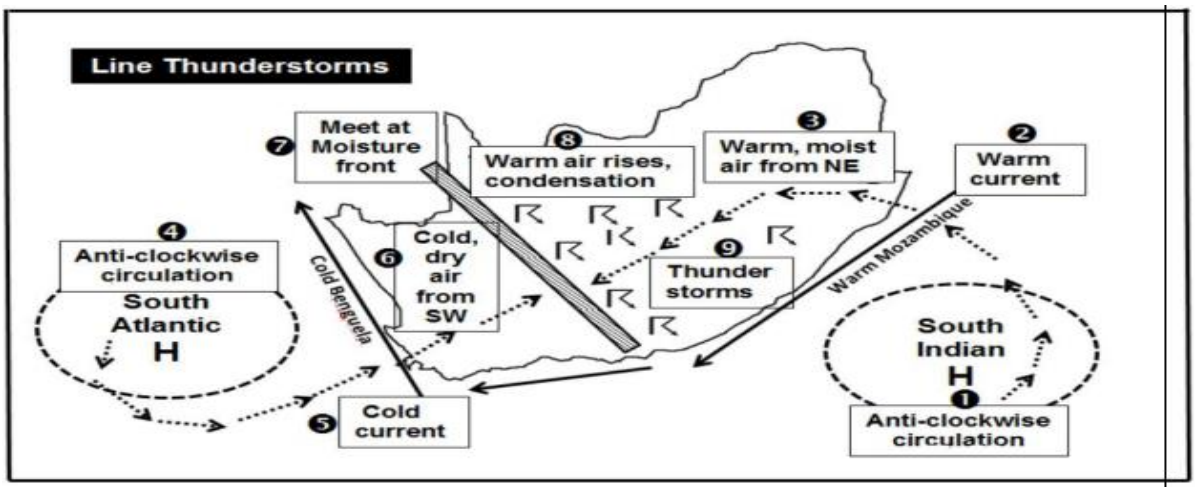
Line Thunderstorms/ The Moisture Front

The moisture front develops where the **cool dry air from the South West** pushed into the country from the South Atlantic HP **meets** the **warm moist air from the North East** (South Indian HP).

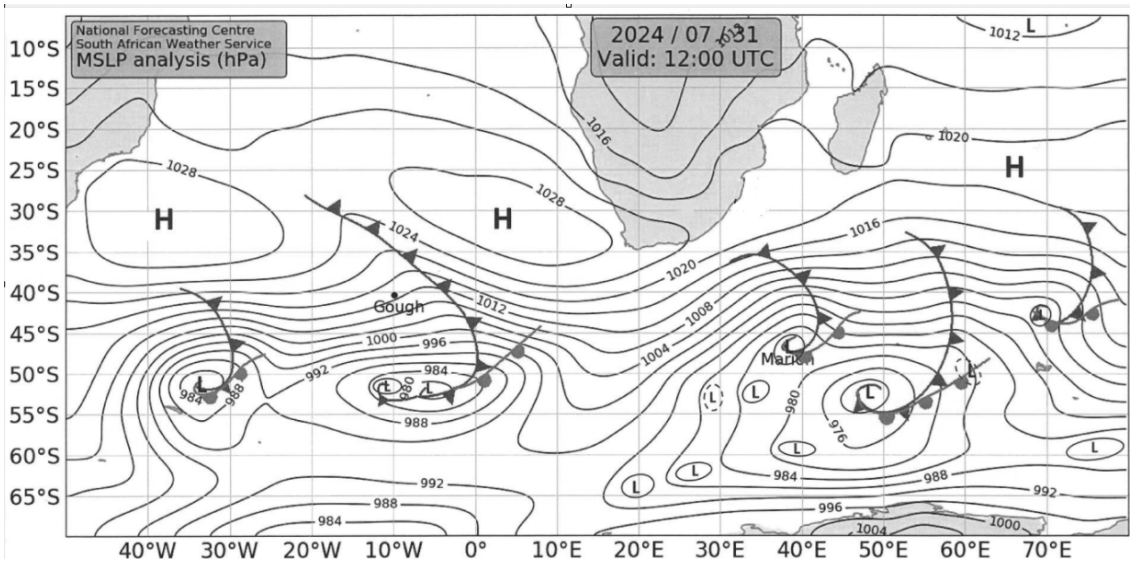
The cool air lifts the warm air and line thunderstorms develop along this boundary

Moisture front develops in summer when the land heats up enough to cause low pressure cells in the interior of the country.

Thunderstorms will form in a line which can extend laterally for hundreds of kilometres**.**



Winter Weather Conditions

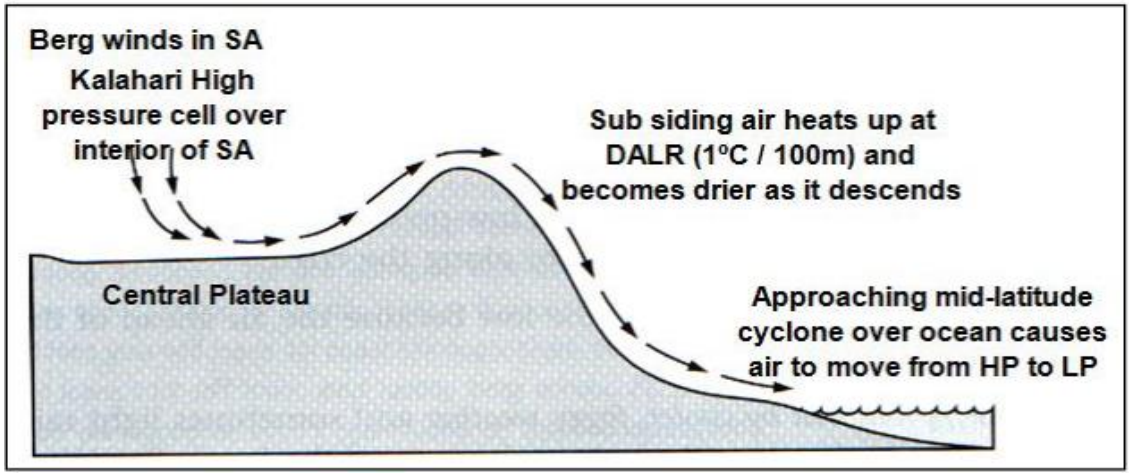


No rain occurs over the interior in winter.

- The South Indian and South Atlantic high pressure systems shift northwards and merge over the country during winter,
- There are largely dry conditions over much of the country.
- Cold fronts, moving mostly over the southern half of South Africa together with the ridging of the South Atlantic high pressure system behind the cold front cause rain, strong winds and gusts during winter over the south western and southern parts of the country.

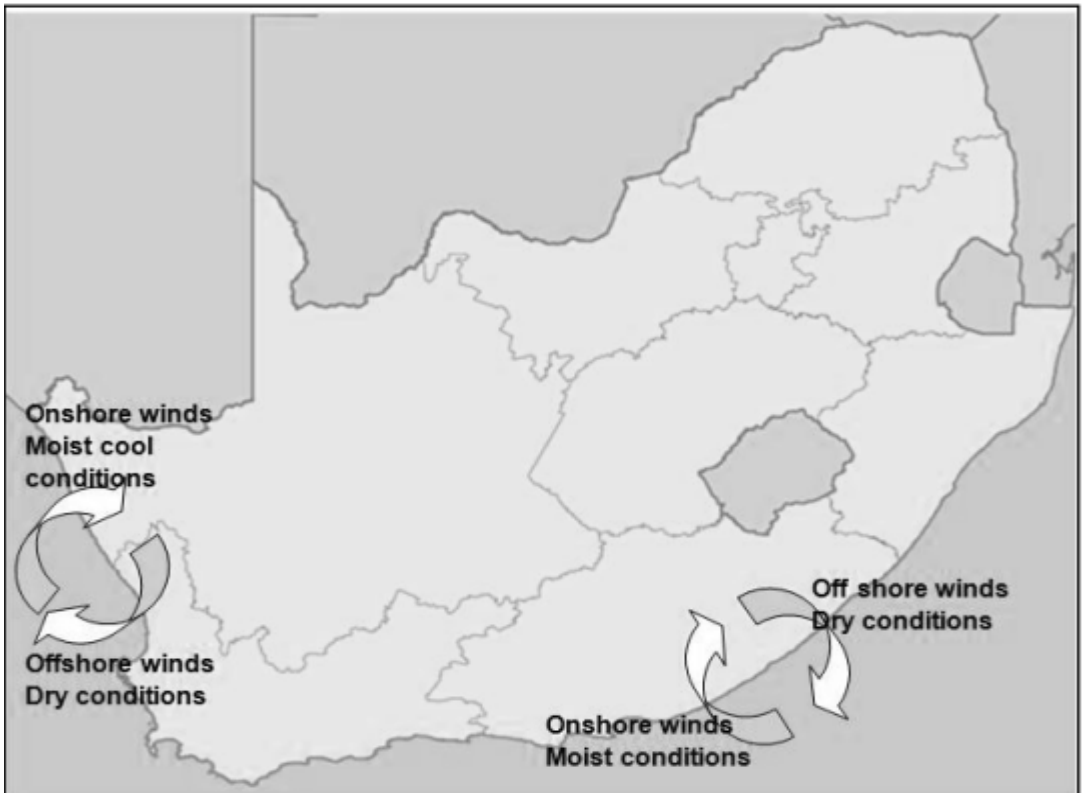
Berg Winds

- Ahead of the mid latitude cyclone, berg wind conditions occur.
- Air blows from the Kalahari High Pressure cell to the costal low pressure
- As the air subsides from the plateau and down the escarpment, it heats at Dry Adiabatic temperature lapse rate and **become drier and hotter**.
- This causes hot dry uncomfortable conditions which is generally replaced quickly with cold conditions associated with the cold front.
- It causes veld fires.



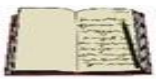
Coastal Low-Pressure Systems

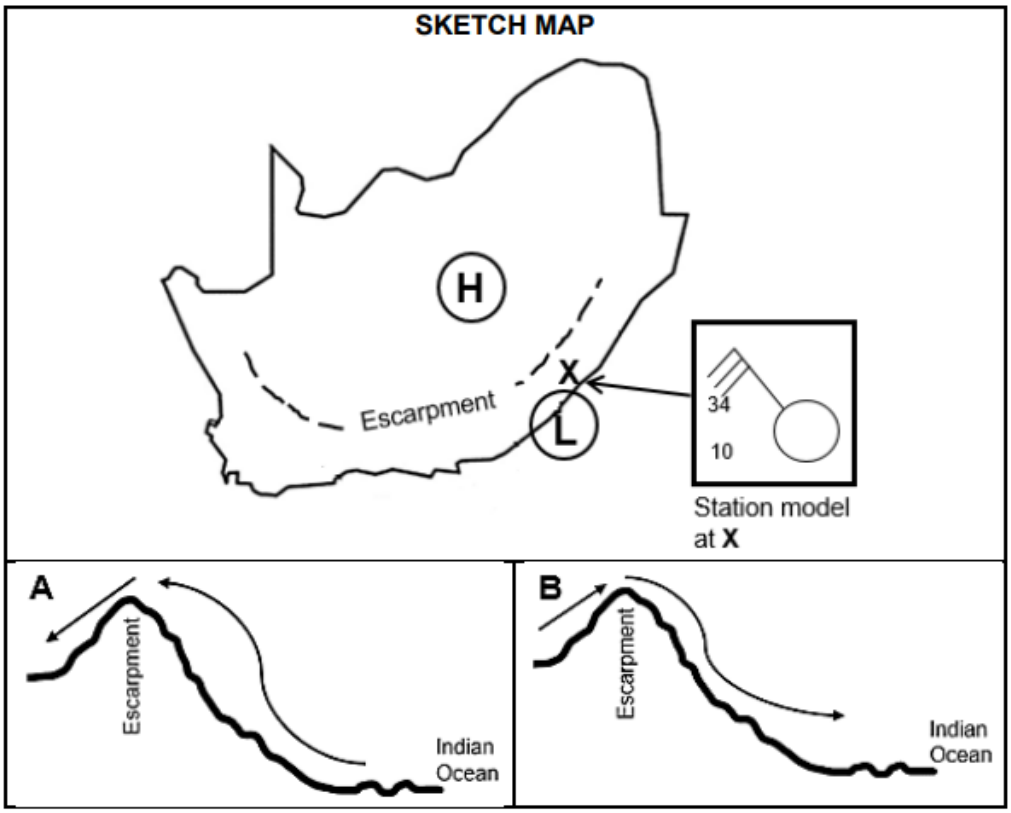
- Coastal Low-pressure systems develop during summer and winter in SA
- The air moves in a clockwise direction around the cell.
- On the **southern** side of the pressure cell, air will move from the land to the sea (**offshore winds**) and will cause warmer drier conditions.
- On the **northern** side of the pressure cell where the air move from the sea to the land (**on shore winds),** moist cloudy conditions will develop that can lead to precipitation along the coastline



ACTIVITY 6

Refer to the sketches below on berg winds.



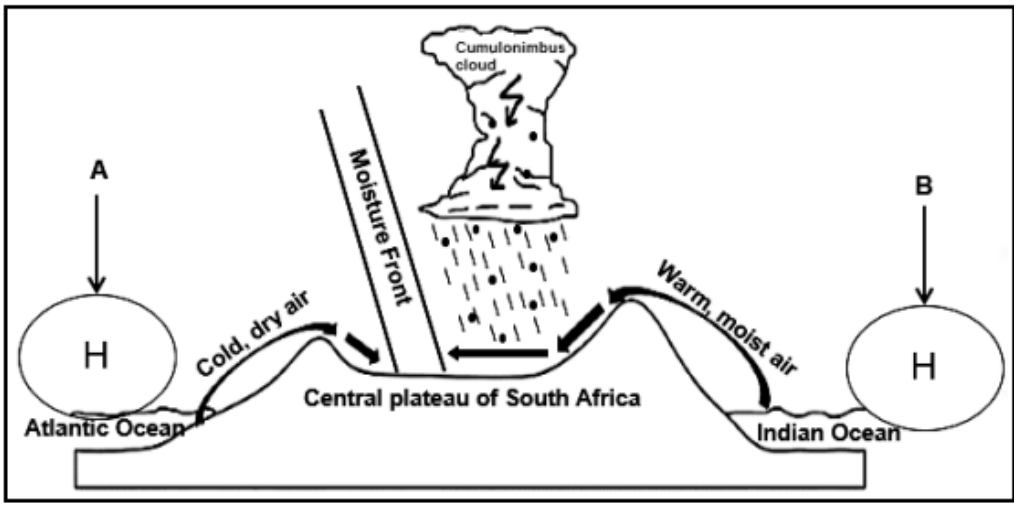


[Source: Examiner's own sketch]

6.1.1	Name the high-pressure cell and low-pressure cell indicated on the sketch map that leads to the development of berg winds.	(2x1)	(1)
6.1.2	Which sketch (**A** or **B**) represents the formation of berg winds?	(1x1)	(1)
6.1.3	Give a reason for your answer to QUESTION 6.1.2	(1x2)	(2)
6.1.4	Explain why cloudless conditions are indicated by the station model at X on the sketch map.	(1x2)	(2)
6.1.5	In a paragraph of approximately EIGHT lines, explain how berg winds impact negatively on the natural vegetation and suggest strategies that can be put in place to limit this negative impact.	(4x2)	(8)
			(15)

Activity 7

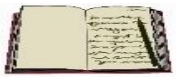
Refer to the sketch below online thunderstorms.

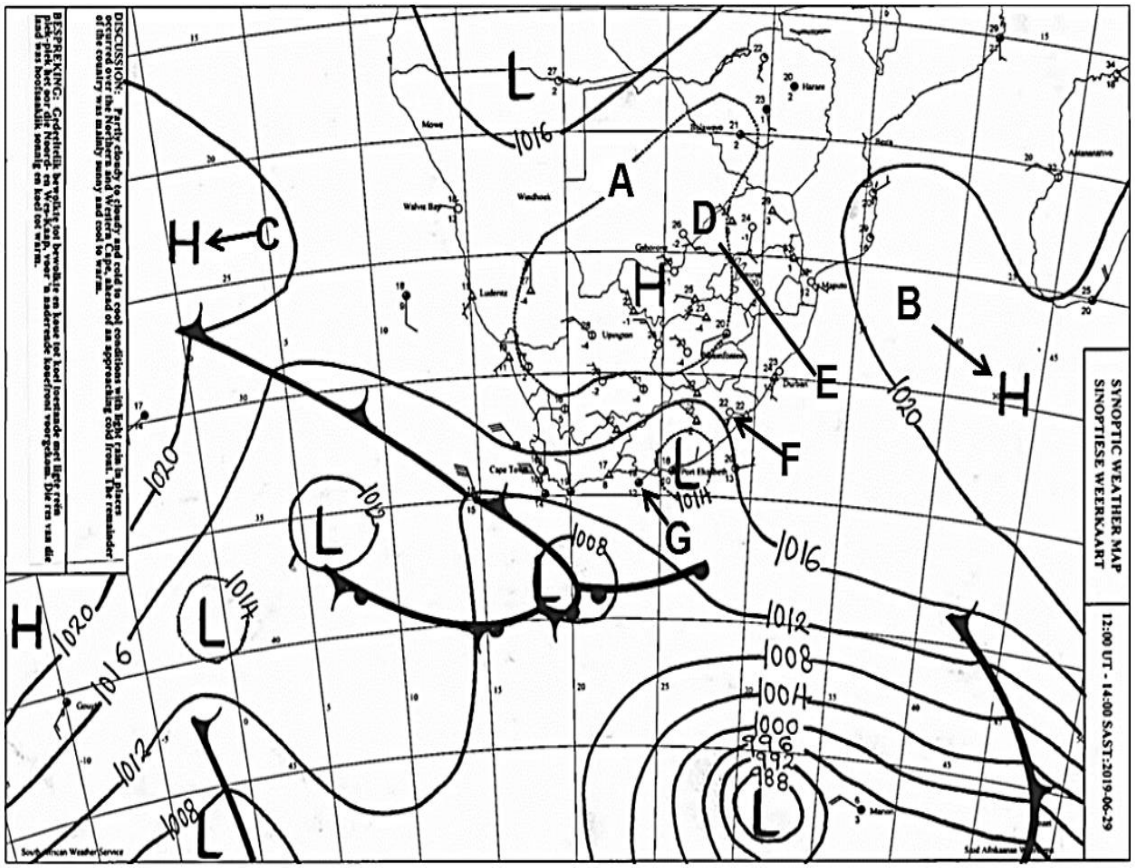


[Source: Examiner's own sketch]

7.1.1	Identify high-pressure cells **A** and **B**.	(2x1)	(2)
7.1.2	Which season is represented by the sketch?	(1x1)	(1)
7.1.3	Give ONE reason from the sketch for your answer to QUESTION 7.1.2.	(1x2)	(2)
7.1.4	What is a moisture front?	(1x2)	(2)
7.1.5	Name TWO forms of precipitation associated with a line thunderstorm.	(2x1)	(2)
7.1.6	Describe the processes involved in the formation of line thunderstorms.	(3x2)	(6)
			(15)

Activity 8
synoptic weather map





8.1.1 Determine the isobaric pressure of isobar **A**. (1x1) (1)

8.1.2 Account for the position of anticyclones **B** and **C** in the season represented by the synoptic weather map. (2x2) (4)

8.1.3 The position of the Kalahari High causes very little chance of rainfall during winter.
Draw a labelled cross profile from **D** to **E** to illustrate the reasons for this lack of clouds and rainfall in winter. (4x1) (4)

8.1.4 What is a moisture front? (1x2) (2)

8.1.5 In a paragraph of approximately EIGHT lines, explain the differences in humidity/moisture levels experienced at weather stations **F** and **G** . (4x2) (8)

(15)

Drainage basins in South Africa

Concepts (definition, identification and application) of:

Types of rivers (definition, identification and application

Identification, underlying rock structure, development and characteristics of the drainage patterns:

Definition and impact of factors influencing drainage density:(high/low drainage density):

Identification, description, formation and significance and impact of fluvial landforms/features

Determining stream order (definition, identification and interpretation)

Discharge of a river: (definition, identification and application)

River profiles:
Definition, description and associated characteristics including stream load

- Cross/Transverse profile
- Longitudinal profile
- Plan view of both profiles
- Relationship of both profiles to the stages of a river (upper, middle, lower course)

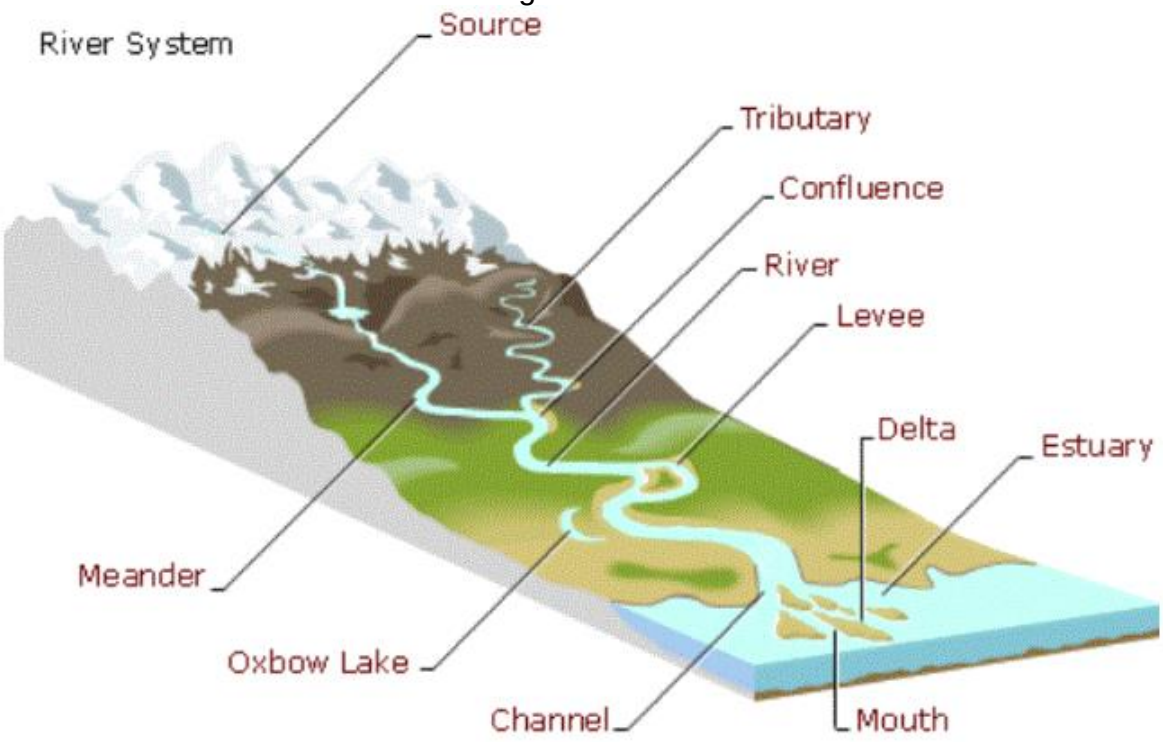
Identification, description, formation and significance and impact of fluvial landforms/features:

- Meander
  Undercut slope
  Slip-off slope
- Oxbow Lake
- Braided stream
- Flood plain
- Natural levee
- Waterfall
- Rapid
- Delta

River grading:
River rejuvenation
River capture/Stream piracy:
Superimposed and antecedent drainage patterns
Catchment and river management

IMPORTANT TERMS AND DEFINITIONS

Drainage basin	an entire river system or an area drained by a river and its tributaries.
Catchment area	an area of land where water collects when it rains, often bounded by hills. As the water flows over the landscape it finds its way into streams and down into the soil, eventually feeding the river.
River system	A river system includes the river, all its tributaries, and any groundwater resources in the area.
Tributary	freshwater stream that feeds into a larger stream, river.
Confluence	The point where a tributary joins a larger river,
Watershed	High lying area diving two drainage basins
Interfluve	an area of higher ground between two rivers in the same drainage system.
Source	the place where a river begins
River mouth	The place where a river enters a lake, larger river, or the ocean
Surface run-off	is the unconfined flow of water over the ground surface
Infiltration	the process by which water on the ground surface enters the soil.
Groundwater	the water present beneath Earth's surface in rock and soil pore spaces and in the fractures of rock formations.
Water table	The level of underground water



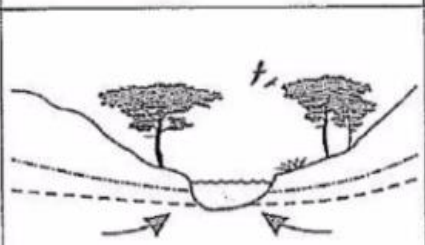
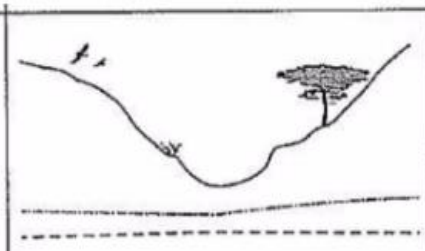
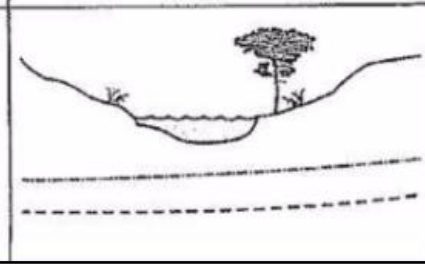
Types of Rivers

Permanent rivers are always flowing even if the level fluctuates. This is common in wet areas. These rivers mostly run into the sea. Only half South Africa's rivers are permanent..

Periodic rivers fed by groundwater only in the rainy season when the water table is higher than the level of the riverbed. These are seasonal rivers.
Common in drier areas. Many periodic rivers never reach the sea but can empty into inland drainage basins.

Episodic rivers never receive groundwater and only flow when there is an episode of heavy rain.

Exotic rivers These are rivers that flow through arid (desert) regions. flows from a wet area and then through a dry area

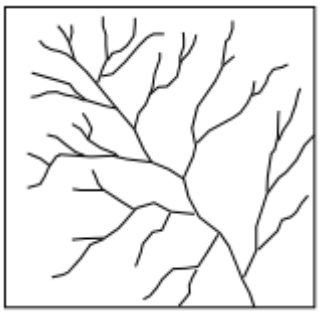
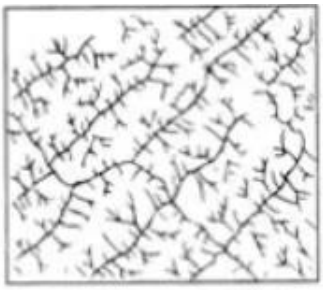
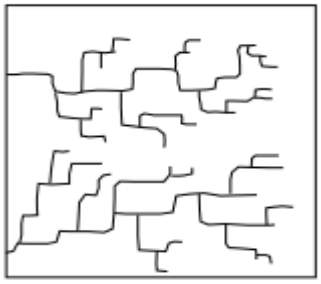
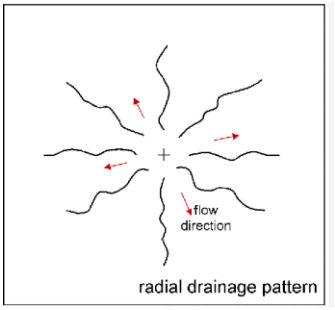
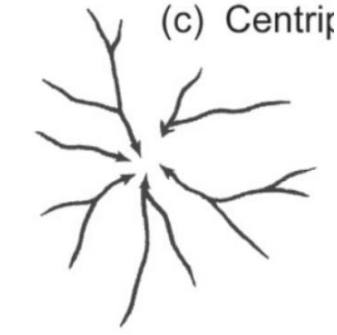
Type	Cross-profile*	Description
Permanent		The river channel intersects both the wet and dry season water table. The river will flow throughout the year. Example - most rivers along the East Coast of SA.
Episodic		The river channel does not intersect either wet or dry season water table and only flows during heavy rains and flash flooding.
Exotic		The river's water source is in a wet area. This supply of water allows the river to flow through drier areas throughout the year. Example - The Gariep River near Upington.

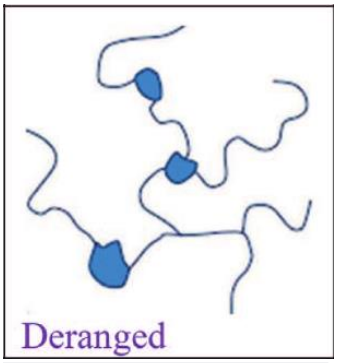
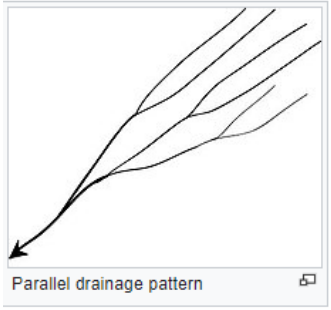
Base flow Underground water seeping into the river.
Water table Upper surface of the zone of saturation in the underlying rocks.
Wet season The time of year when it normally rains in a particular area.
Dry season Season of the year when it does not normally rain in a particular area.
Cross-profile The shape of the river channel from bank to bank.

Wet season water table
Dry season water table
Seeping into the ground water channel as base flow

Orange River Rivers

Drainage patterns

Pattern	Identification	Description	Underlying structure
<u>Dendritic</u>		Tributaries join the main stream at acute angles. Resembles the branches of a tree.	They develop on a land surface where the underlying rock is of uniform resistance to erosion.
Trellis		Tributaries join the main stream at right angles. Main streams are parallel to each other	Occurs in areas of folded sedimentary rocks. Occurs in areas where hard rocks and soft rocks alternate.
Rectangular		The mainstream displays right-angle bends	Develop where linear zones of weakness, such as joints or faults cause the streams to cut down along the weak areas in the rock.
Radial		Streams radiate from a central point.	develop surrounding areas of high topography where elevation drops from a central high area to surrounding low areas. Develop on a dome structure
Centripetal		Streams converge into a low-lying area. rivers discharge their waters from all directions in a lake or depression	Basin like structure

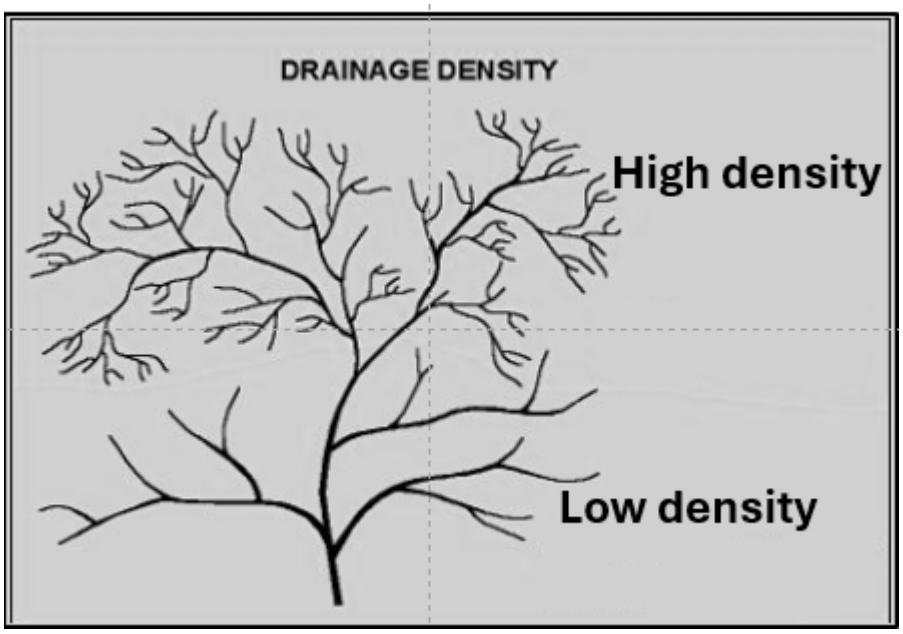
Deranged		Streams have irregular patterns. Tributaries do not link up with the main stream	Occur in regions subjected to glaciation
Parallel		Pattern of rivers caused by steep slopes with some relief. Because of the steep slopes, the streams are swift and straight, with very few tributaries, and all flow in the same direction.	A parallel drainage system occurs on elongate landforms like outcropping resistant rock bands), typically following natural faults or erosion (such as prevailing wind scars)

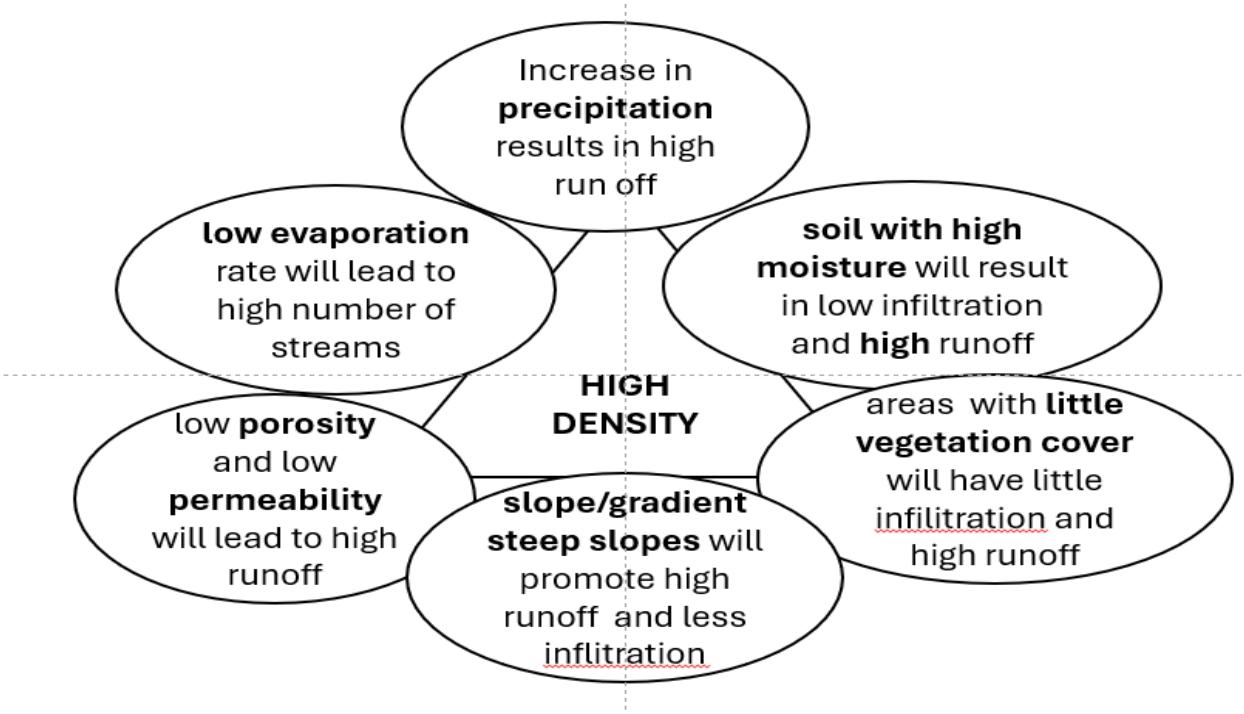
Drainage Density

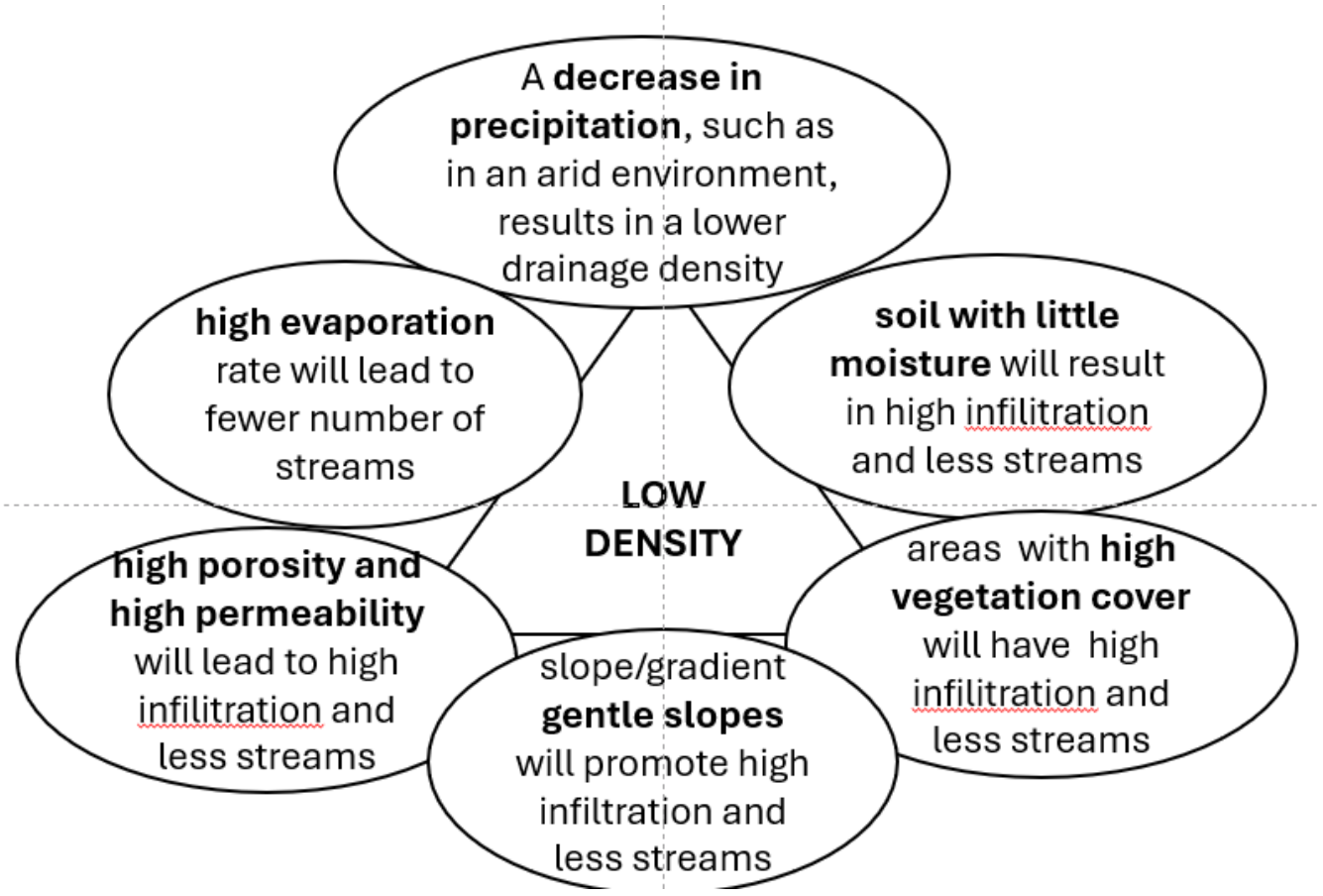
The drainage density is the measure of the length of stream channel per unit area of drainage basin. It describes how many streams there are in a drainage basin

Drainage Density is affected by **infiltration** and **surface runoff.**

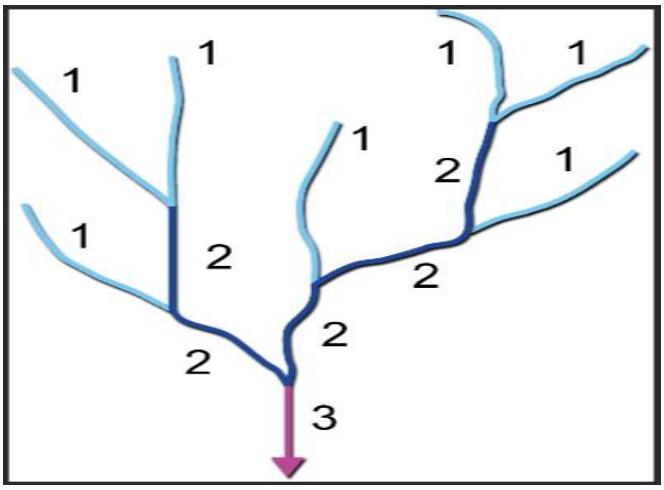
Infiltration: the downward movement of water through tiny pores in the soil.
Surface runoff: movement of water across the ground which occurs when either the rainfall is too heavy for water to infiltrate into the soil, where the soil is impermeable, or when the soil has become saturated.




Increase in **precipitation** results in high run off
low evaporation rate will lead to high number of streams
soil with high moisture will result in low infiltration and **high** runoff
HIGH DENSITY
low **porosity** and low **permeability** will lead to high runoff
areas with **little vegetation cover** will have little infilitration and high runoff
slope/gradient steep slopes will promote high runoff and less inflitration


A **decrease in precipitation**, such as in an arid environment, results in a lower drainage density
high evaporation rate will lead to fewer number of streams
soil with little moisture will result in high infilitration and less streams
LOW DENSITY
high porosity and high permeability will lead to high infilitration and less streams
areas with **high vegetation cover** will have high infilitration and less streams
slope/gradient **gentle slopes** will promote high infiltration and less streams

- Stream ordering is a method of assigning a numeric order to links in a stream network.
- This order is a method for identifying and classifying types of streams based on their numbers of tributaries.
- Some characteristics of streams can be inferred by simply knowing their order



- All links without any tributaries are assigned an order of 1 and are **referred to as first order.**
- **The stream order increases when streams of the same order intersect.**

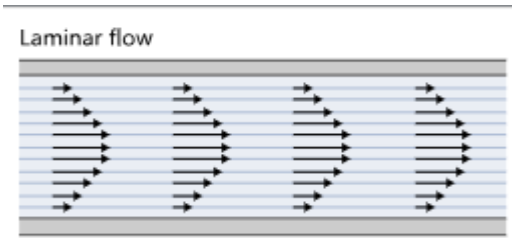
- Therefore, the intersection of two first-order links will create a second-order link,
- The intersection of two second-order links will create a third-order link, and so on.

- The intersection of two links of different orders, however, will not result in an increase in order.
- For example, the intersection of a first-order and second-order link will not create a third-order link but will retain the order of the highest ordered link.

River Discharge

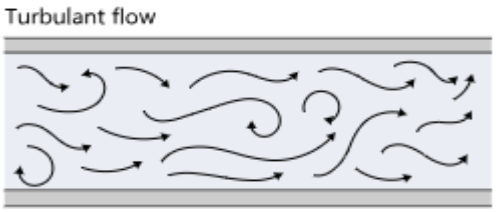
River discharge is the volume of water that flows through a river at a specific point in time.
River discharge flows in two ways through a river:

1. Laminar Flow:
Water flows in parallel layers, with each layer moving smoothly past the next.



more common in the lower course of a river.
In this part of the river, the water flows more smoothly and quietly due to the absence of large rocks and the wider, deeper channel

2. Turbulant Flow
flow in a river is a chaotic, swirling, and loud flow of water that occurs when water particles don't remain in parallel layers.



Turbulent flow is most found in the upper course of a river.
Caused by an uneven riverbed, which can be created by alternating bands of hard and soft rock.

FLUVIAL LANDFORMS

Landforms or features found along the river course that are a result of the fluvial processes

RAPIDS

stretches of fast-flowing water tumbling over a rocky-shallow riverbed.

They are formed when the water goes from one hard rock that resists the water's erosion to a softer rock that is easier eroded.

Used for recreation (river rafting)
Tourist attractions

WATERFALLS

An area where water flows over a vertical or steep drop in the course of a stream or river
It forms when there are horizontal bands of resistant rock (hard rock) positioned over exposed, less resistant rock (soft rock).

The strong currents near falls are often used to generate electricity.
Waterfalls are sometimes a disadvantage since they form a barrier to infrastructure development.
Waterfalls attract tourists.
Waterfalls are aesthetically pleasing.
Waterfalls also provide opportunities for a wide range of, sometimes incompatible, outdoor leisure activities

FLOODPLAINS

The flat area bordering a river, composed of sediment deposited during flooding

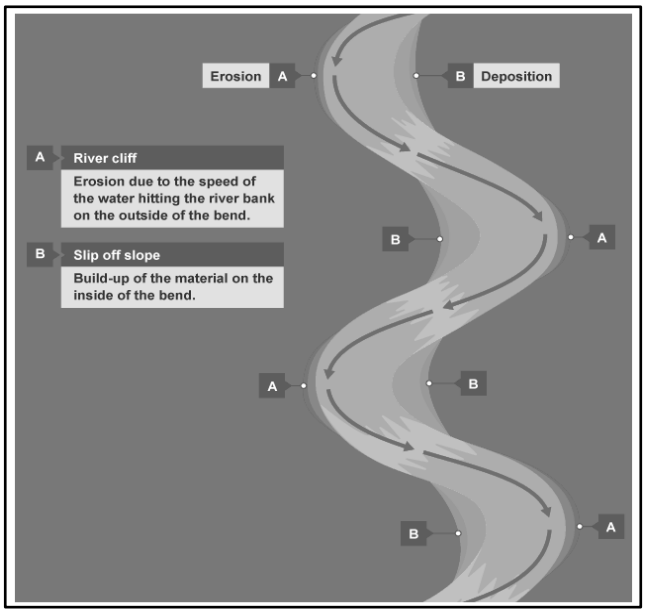
Floodplains form due to mainly deposition.
Because of the gentle gradient, there is more deposition occurring.

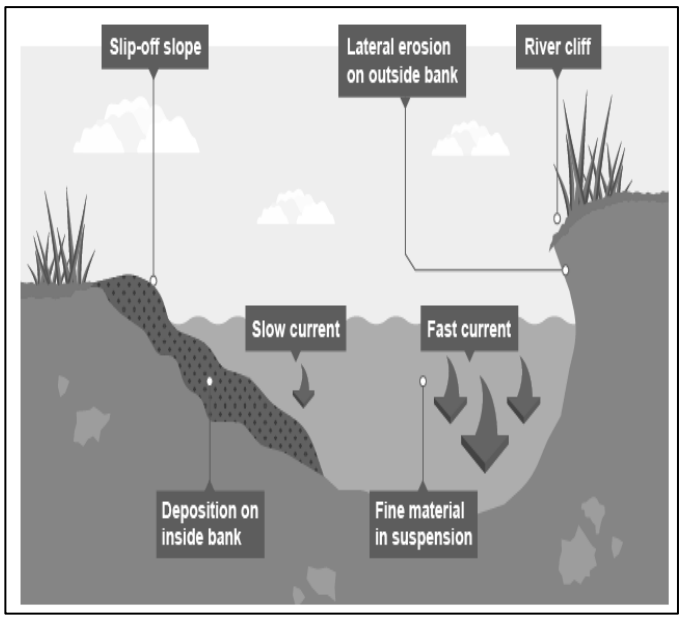
Floodplains provide fertile land for agriculture.
Easy to construct infrastructure.
Flat area is heavily populated.
Settlements develop.
Tourist attraction

Source of water for economic and domestic purposes
They are beneficial for wildlife by creating a variety of habitats for fish and other animals.
It preserves water quality by continuous refreshing due to flooding.
It provided numerous recreational opportunities
Not ideal for settlements as they may be destroyed during times of flooding

MEANDERS

Rivers flowing over gently sloping ground begin to curve back and forth across the landscape
In the middle course the river has more energy and a high volume of water as a result of tributaries joining
Lateral (sideways) erosion starts to widen the river channel.
As the river erodes laterally (to the right side then the left side) it forms large bends, and then horseshoe-like loops called meanders.
The formation of meanders is due to both deposition and erosion and meanders gradually migrate downstream

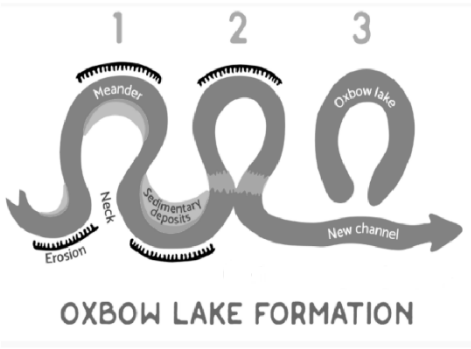




Oxbow lake

The cut-off loop of a meander filled with water.

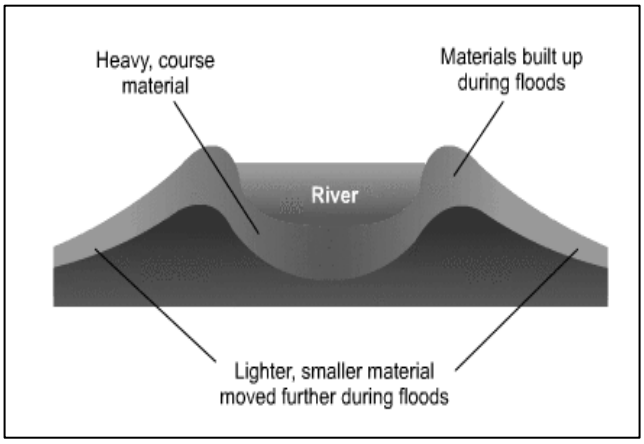
Over time the meander loop becomes tighter, until the ends become very close together.
As the river breaks through, e.g. during a flood when the river has a higher discharge and more energy, and the ends join, the loop is cut-off from the main channel.
Some cities are located in and around meanders for trade purposes. Boats and barges can access



OXBOW LAKE FORMATION

the town to some extent for some trade.
Oxbow lakes can be rich wildlife habitats.
Can be utilised for agricultural purposes especially crop farming.
Tourist attractions

Natural Levees



Levees are formed by the repeated flooding of the river.
When the river floods, the biggest, most coarse material will be deposited.
This will be close to the river banks.
Continuous flooding causes repeated deposition on the river banks.
The banks form levees made of sediment, silt, and other materials.

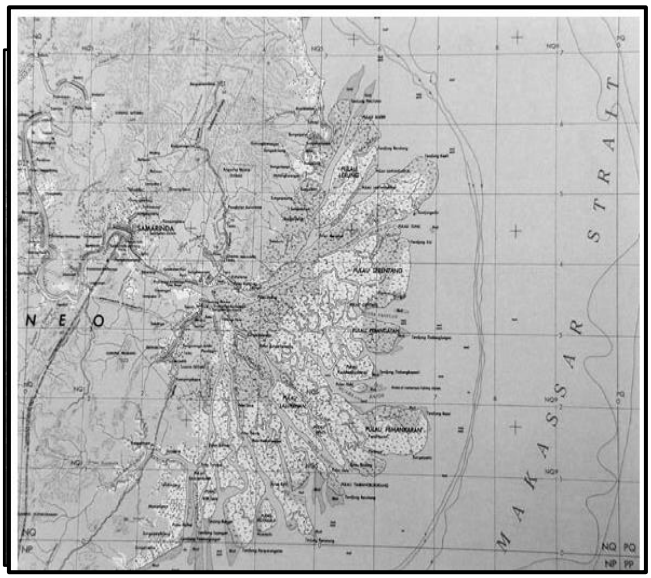
They prevent rivers from flooding.
Levees are usually parallel to the way the river flows, so levees can help direct the flow of the river.
Levees can also provide a measure of protection from invaders.
Fertile soil near levees is suitable for farming.
Levees may be used to increase available land for habitation

BRAIDED STREAMS

A stream consisting of multiple small, shallow channels (distributaries)
They divide and recombine numerous times forming a pattern resembling the strands of a braid.

Braided streams form where the sediment load is deposited as shifting islands or bars between the channels.
•When the river's carrying capacity is exceeded the river deposits its load into the channel.

DELTAS



It is landform at the mouth of a river, where different channels (distributaries) of the same river flow into an ocean or sea.

Source of water for crop farming

The river slows down at the mouth due silt deposits and gentle gradient.

Area preserves bird life

The channel splits into several smaller channels (distributaries) and it loses velocity.

The area hampers the construction of infrastructure

As the river loses velocity it deposits its load on the river bed.

It is therefore expensive to build roads and railway lines

Both the bed load and suspended load are deposited producing fertile alluvial land.

Sand and gravel are quarried from deltas and are utilized for a variety of purposes e.g., road and building construction.

They are important industrial hubs.

Large settlements often grow up in the delta regions.

Deltas are a source of water.

Deltas sustain all ecosystems.

Deltas ensures biodiversity.

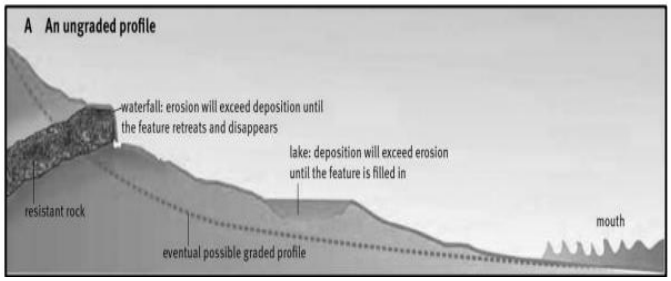
Tourism (leisure activities) opportunities are created by deltas and contributes to the economy.
Can be part of water transport system.
Deltas are a source of protein (fish)
Deltas are usually highly fertile areas and support extensive crop cultivation

River Grading
the process by which a river's slope adjusts over time to transport all of its load

Ungraded River Profile: a river profile that has irregularities/obstruction/temporary base levels along its path. (It is not smooth)

Graded River Profile: a smooth, concave-upward curve that describes the longitudinal profile of a river that has smoothed out its gradient over time.

Ungraded Rive Profile



Graded Rive Profile

The process that a river profile must undergo from an ungraded to a graded profile

Downcutting:
The river begins the process by downcutting into the riverbed, creating a deep channel.
Downwards erosion occurs in the upper course and causes a steep slope.
Backward erosion removes temporary basis of erosion like waterfalls.
Rapids are removed by means of downward erosion.

Transportation:
The river picks up sediments and carries them downstream, further shaping the channel.

Deposition:
As the river slows down, it deposits the sediments it has been carrying, which can help to build up the riverbed and banks.
Obstructions like lakes are filled in the middle course.

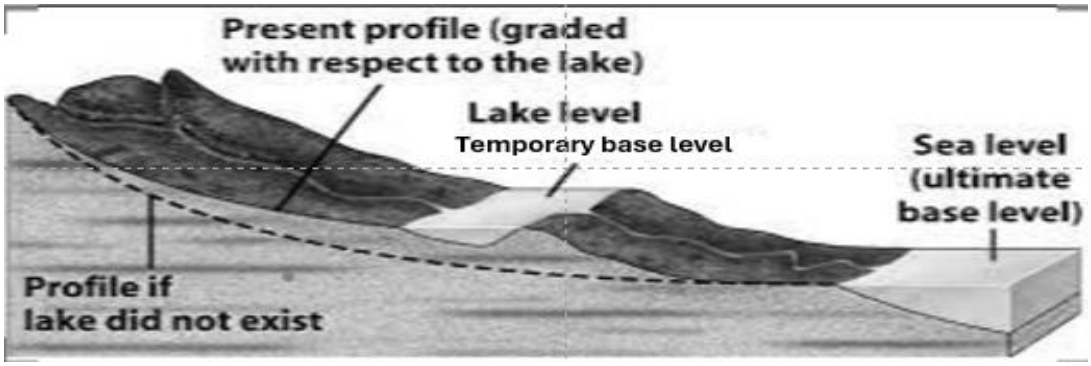
Deposition occurs in the lower course because the slope is gradual.
The steep slope in the upper course and the gradual slope in the lower course causes concave shape.

Graded profile:
Eventually, the river reaches a state of equilibrium, where it has a smooth, consistent gradient and a balanced flow of water and sediment. This is known as a graded profile

Base level of erosion
the lowest point to which running water can erode a stream channel

Temporary Base level of erosion
temporary feature that limits the erosive power of a river or streams at a local level.
It can be a lake, a resistant rock layer, or a man-made structure like a dam.
The local base level can be raised or lowered by changes in the landscape or human activities.

Permanent or Ultimate Base level of erosion
This is the lowest level that a river can erode its channel, which is usually the **sea level**.
The ultimate base level is a permanent feature that cannot be lowered any further by the erosive power of the river.

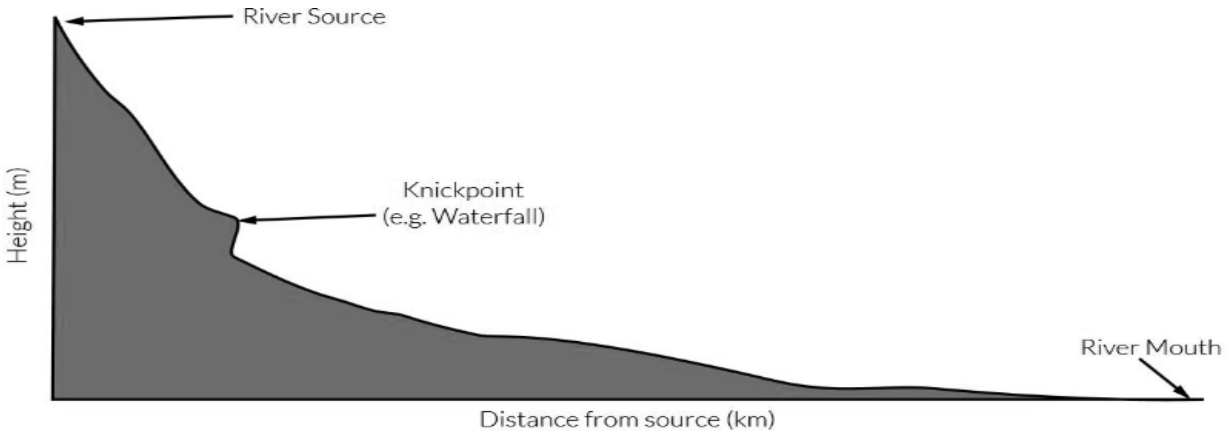


River Rejuvenation
When a river renews its erosive power.

Causes of rejuvenation
Tectonic changes
Earthquakes can cause an uplift along fault lines to create fault scarps several metres high. If this crosses a river, a waterfall will form, and the river will begin eroding vertically at this point.
Fall in sea level caused **by eustatic** changes – during a glacial period, water is stored on land as ice so the sea level changes
Fall in sea level caused **by isostatic** changes – after a period of glaciation the land will start to rise in response to the loss of the weight of the ice. This is called isostatic recovery.
River capture – over time rivers cut backwards at their source.

Landforms created by rejuvenation

Knick Points

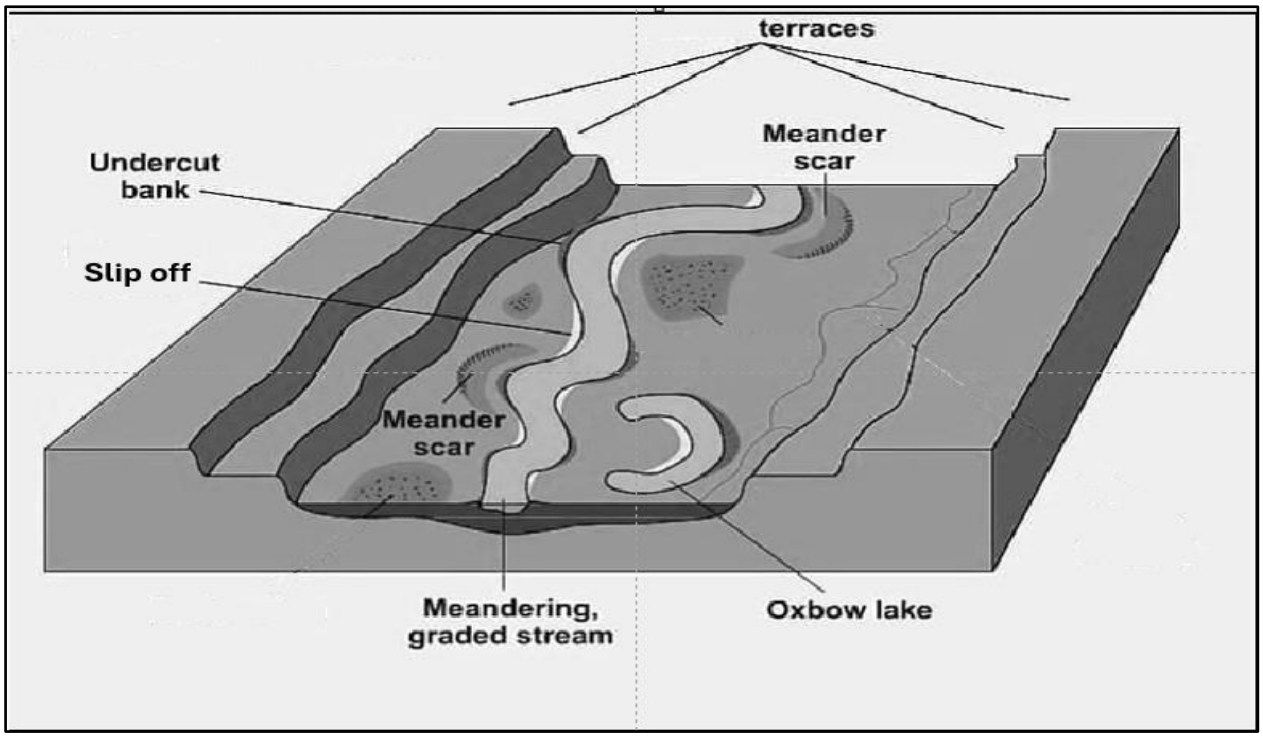


A knick point is a sharp break of slope in the smooth, concave long profile of a river.
It is usually marked by the presence of a waterfall (or a series of rapids).
At this point vertical erosion associated with rejuvenation is at its greatest.
The knick point retreats upstream over time.

Incised meanders

Meanders sweeping bends in rivers.
They are usually found along the lower course of a river where lateral erosion is greater than vertical.
However, when rejuvenation occurs vertical erosion begins to dominate the lateral erosion that usually occurs in a meander (with erosion on the outside bend).
This results in a steep sided meander that is cut into the floodplain. It may become entrenched (symmetrical steep sides on both sides of the river) and form a winding gorge like that of the Grand Canyon.

River terraces



River terraces are old floodplains left perched above the current floodplain.
Following rejuvenation, the river will cut down into its channel and will gradually form a new floodplain.
The old one is left high and dry.

Significance of rejuvenated landscapes

- Settlements are frequently built on river terraces because they represented land safe from flooding. Much of London is constructed on a river terraces.
- **Ecological benefits**: Rejuvenation of landscapes can help restore forests, grasslands, wetlands, and other ecosystems. This can help alleviate poverty and generate sustainable livelihoods.
- **Tourist attractions**: Landforms in rejuvenated landscapes can be good for tourism.
- **Recreation**: People can visit areas with terraces for recreation.
- **Power generation**: Water at knick point waterfalls can be used for power generation.
- **Crop farming**: Old floodplains can be suitable for crop farming.
- **Complex landscapes**: Rejuvenated terrains often have complex landscapes because remnants of older landforms are preserved.

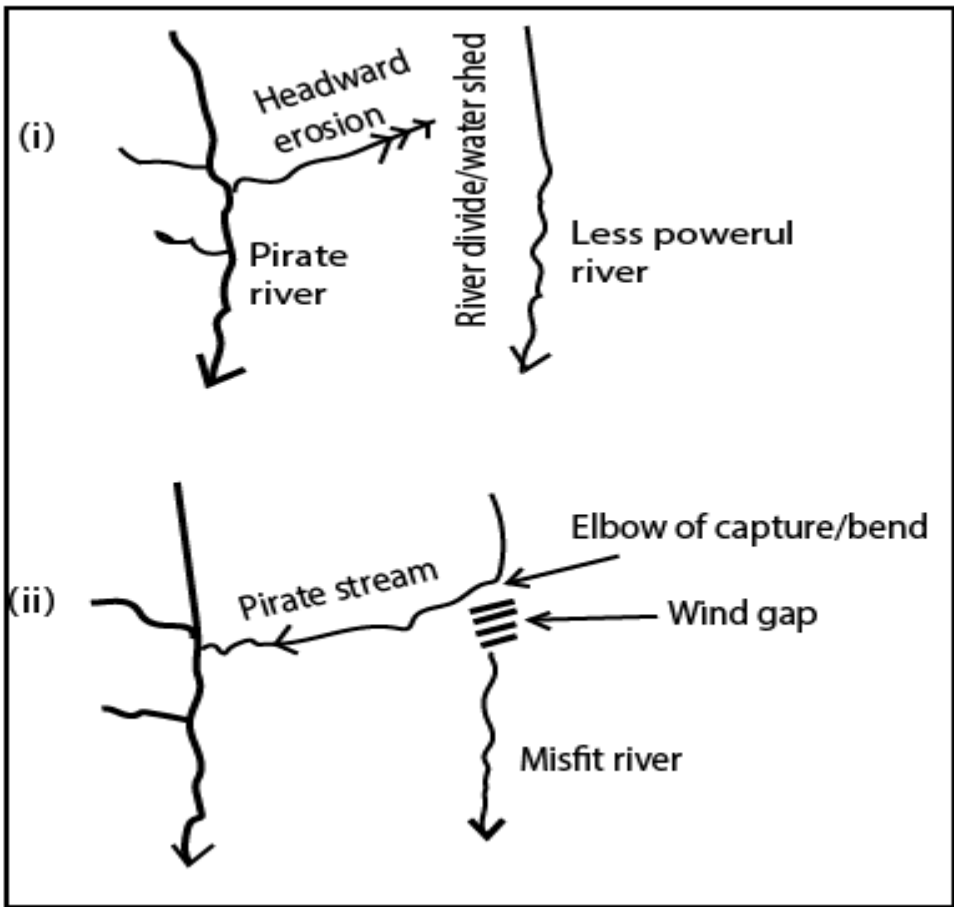
River capture/Stream piracy

River Capture: Occurs when one more energetic river captures headwaters of a less energetic river
Abstraction: the process of a watershed moving and lowering in the direction of a less energetic stream
Headward erosion: a fluvial process that occurs when a stream erodes in an upstream direction, lengthening the stream and its valley.
It happens at the headwaters of a stream, where the stream erodes away at the soil and

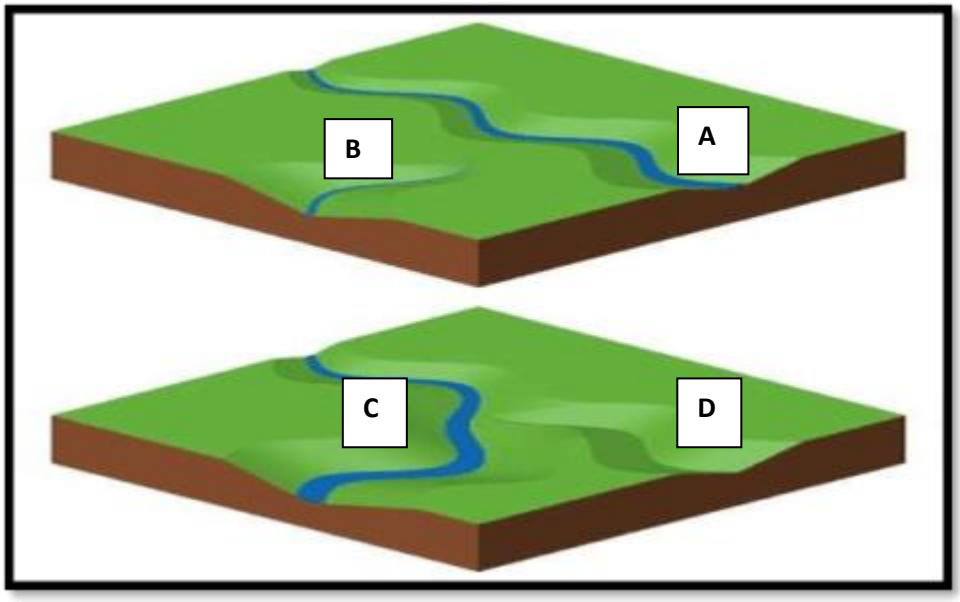
rock in the opposite direction that it flows

Captor stream: the energetic stream that cuts back and intercepts the other river.
Captured stream: a stream that has been diverted from its own bed and is now flowing in the bed of a neighboring stream.
Misfit stream: The river that has lost its headwaters as a result of capture.
a river or stream that is too small to have eroded the valley or cave passage flows through.
Elbow of capture: the point of capture where the change of flow direction occurs.
Wind gap: This is the area between the elbow of capture and the misfit stream where the water stops flowing and river gravels are deposited.

How does river capture occur?
One river(captor) has a steeper gradient than the other river (captured).
One river has a (captor) less resistant underlying rock than the other river(captured)
One river flows faster than the other river.



Physical impact of river capture
Captor stream
The captor stream after a river capture can undergo rejuvenation.
It will have high flowing velocity and high erosion ability.
The captor stream will also experience an increase in volume of water.
Rejuvenation of captor stream can result in more turbulent flow and developments of rapids and waterfall.
The additional water in the capturing stream may increase erosion and lead to canyon formation



Misfit Stream
The misfit stream is deprived of water and shrinks.
The misfit stream will shrink to a size that's too small for its valley.
The valley of the original stream may become dry, known as a wind gap.

Implications of river capture for human activities, settlements, recreation, agriculture and ecosystems

Change in water supply: When a river captures another river, it changes the water supply in the area.
The misfit river will experience a reduction in water flow, while the captor river will have more flow.
This can impact on the availability of water for the settlement.

Change in riverbed: The captured river will have a different gradient and sediment load, which can cause changes in the riverbed.
These changes can impact on the settlement's access to the river and the surrounding land.

Economic impact: Settlements along the misfit river may depend on the river for irrigation, fishing, and transport.
River capture can disrupt these activities and impact negatively the settlement's economic activities.

Environmental impact: River capture can have a negative impact on the ecosystem of the misfit river and the surrounding area.
Changes in water supply and riverbed can have a negative impact on the flora and fauna in the area, and the settlement may need to adapt to these changes.

Loss of Water Supply: River capture can alter the natural flow patterns of rivers and streams, potentially reducing the water availability for farming in the affected regions.
If the Misfit Stream is captured by another larger river, the water that was previously accessible for irrigation and other farming purposes may be diverted away, leading to water scarcity for farmers.

Soil Erosion: When rivers capture the flow of other streams, erosion can occur along the newly captured river's course.
This erosion can result in the removal of fertile topsoil from farmland, negatively

impacting agricultural productivity.
Soil erosion can affect the ability of crops to grow, disrupt drainage systems, and increase the risk of flooding in nearby agricultural areas.

Altered Nutrient Flow: River capture can change the nutrient dynamics of an area. If the Misfit Stream's flow is captured by another river, it may result in a shift in the distribution of sediment and nutrients that were previously brought into the surrounding farmland.
The change in nutrient availability can affect soil fertility, potentially leading to decreased crop yields and reduced agricultural productivity.

Disrupted Irrigation Systems: Many farming practices in areas near rivers rely on irrigation systems that draw water directly from the river or stream.
If river capture diminishes the flow of the Misfit Stream, it may disrupt existing irrigation infrastructure built around the river, rendering it inefficient or ineffective.
Farmers may need to invest additional resources in constructing alternative irrigation systems, leading to increased costs and reduced profitability.

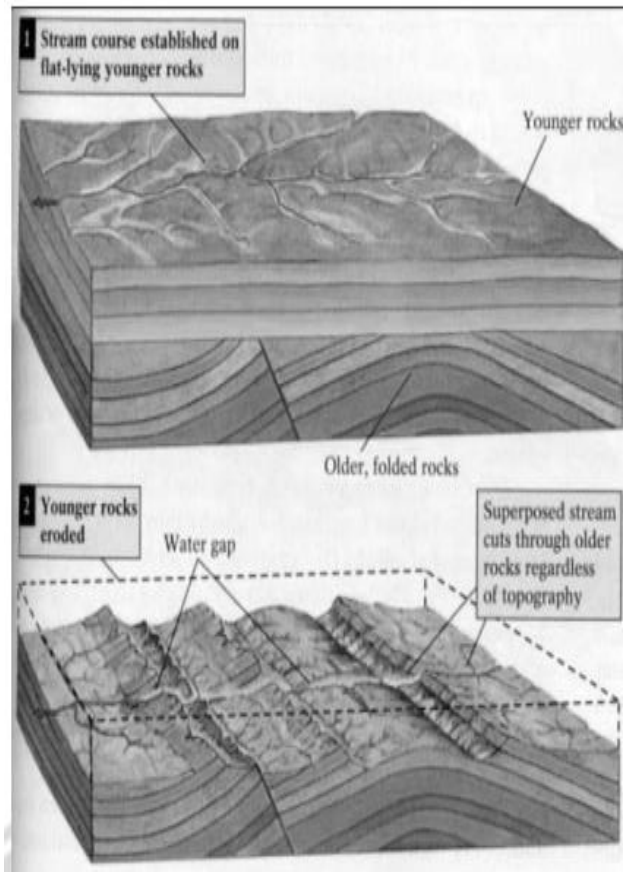
Impact on Livestock: Many farmers around the Misfit Stream may rely on the availability of freshwater for their livestock.

River capture can limit the access to water for animals, potentially leading to a shortage of drinking water and negatively impacting animal health and productivity.

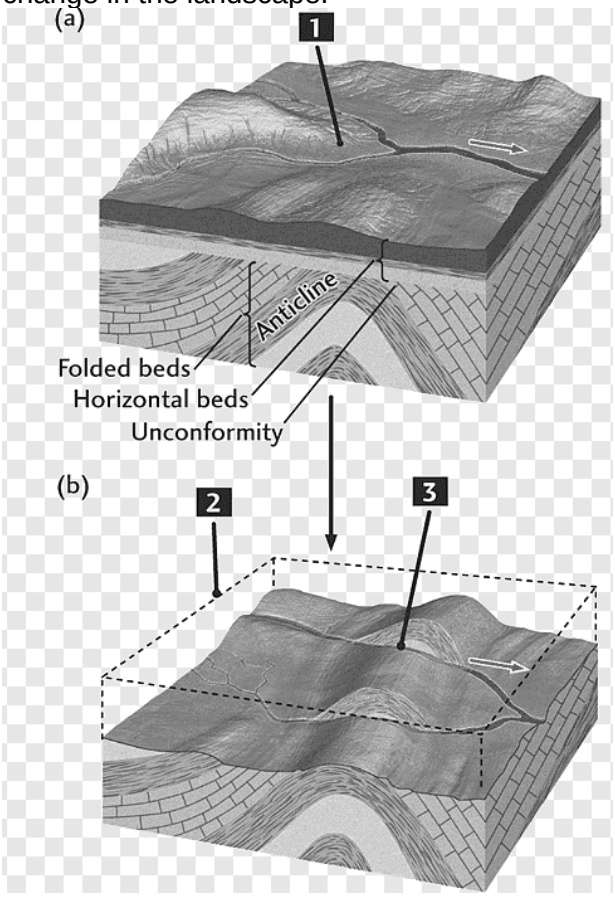
Superimposed and antecedent drainage patterns

Superimposed
A river system that cuts through a landscape of sedimentary rocks, appearing to have no relation to the underlying rock bed.

new river starts flowing over a surface of newly formed rocks.
due to weathering this rock layer is removed and now the river starts flowing over the newly formed surface which is made of older rocks.
Thus, the river has now superimposed itself on a new surface that is made of older rocks.
A drainage system develops on a surface of younger rocks but is later removed. The river then continues to flow over a surface of older rocks



Antecedent
A type of river system that maintains its course through a landscape that has changed around it, such as through tectonic uplift or mountain formation
Antecedent drainage patterns often cut through mountain ranges or other landscape features that would normally inhibit river flow.
The word antecedent means something that existed before.
this case a river has been in existence much before any change in the landscape
Antecedent rivers are older than the landscape around them.
a river has been in existence much before any change in the landscape.

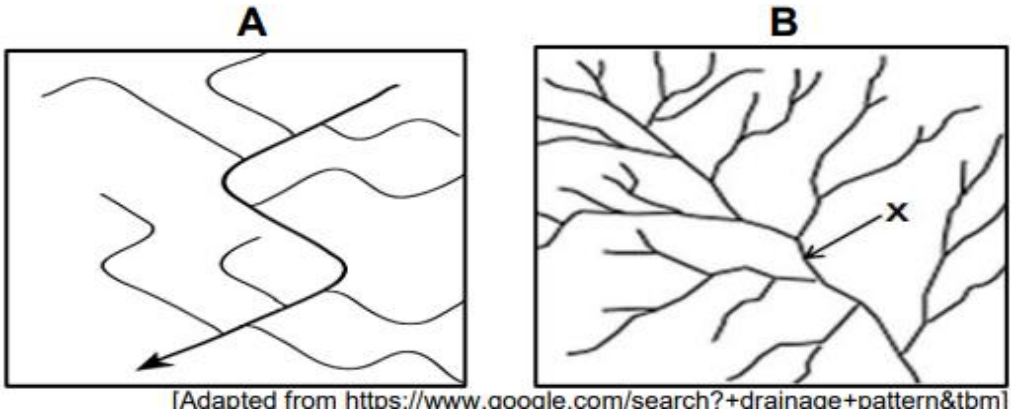


Activity 9

Refer to the drainage patterns illustrated in sketches A and B below

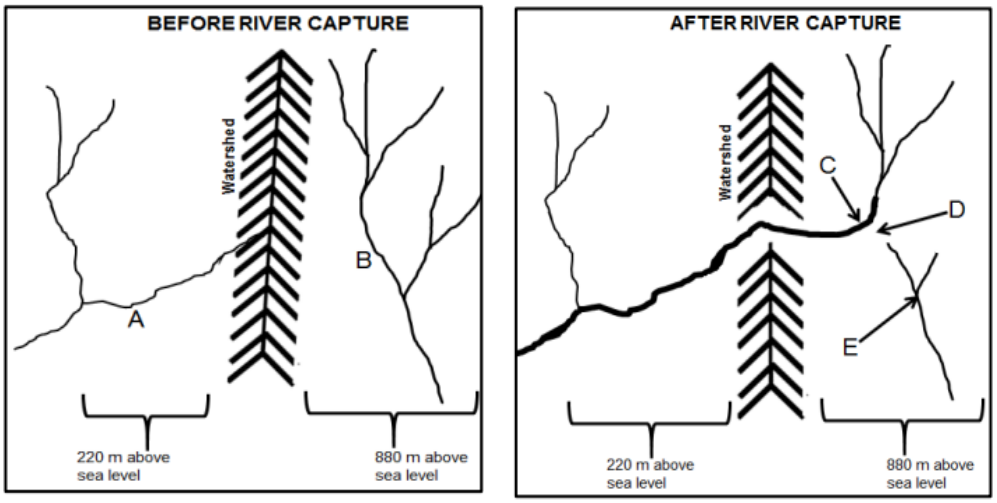
Activity 10

Refer to the sketches below on river capture (stream piracy).



[Adapted from https://www.google.com/search?+drainage+pattern&tbm]

9.1.1	Identify drainage patterns in sketches **A** and **B**	(2x1)	(2)
9.1.2	State the underlying rock structure and rock type on which the drainage pattern in A developed.	(1+1)	(1)
9.1.3	Explain how the underlying rock structure influenced the drainage pattern in **A**.	(1x2)	(2)
9.1.4	The drainage density in **B** is (high/low).	(1x1)	(1)
9.1.5	Determine the stream order at **X**.	(1x2)	(2)
9.1.6	Explain the relationship between stream order and drainage density in **B.**	(1x2)	(2)
9.1.7	Explain how the slope (gradient) and permeability of underlying rock influence the drainage density in **B**.	(2x2)	(4)



[Source: Examiner's own sketches]

10.1.1	Which river (**A** or **B**) has more erosive power?	(1x1)	(1)
10.1.2	Give ONE reason evident in the sketches to support your answer to QUESTION 10.1.1.	(1x2)	(2)
10.1.3	Identify features **C** and **D.**	(2x1)	(2)
10.1.4	Give ONE characteristic of feature **D**.	(1x2)	(2)
10.1.5	In a paragraph of approximately EIGHT lines, describe the changes that river **E** will experience after river capture has taken place	(4x2)	(8)

Refer to the photograph of a valley below to answer QUESTIONS 11.1.1 and 11. 1.2.

VALLEY

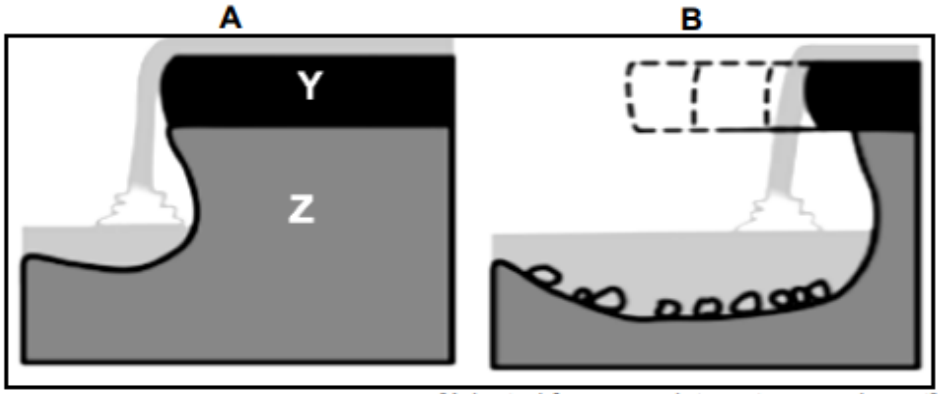
[Source: https://www.gettyimages.ac/valleys]

11.1.1 The valley in the photograph is generally found in the (upper/middle) course. (1x1) (1)

11.1.2 Identify TWO characteristics visible in the photograph to support your answer to QUESTION 11.1.1 (2x2) (4)

Refer to sketches **A** and **B** below of a waterfall to answer QUESTIONS 11.1.3 to 11.1.5.

WATERFALL



[Adapted from www.internetgeography.net]

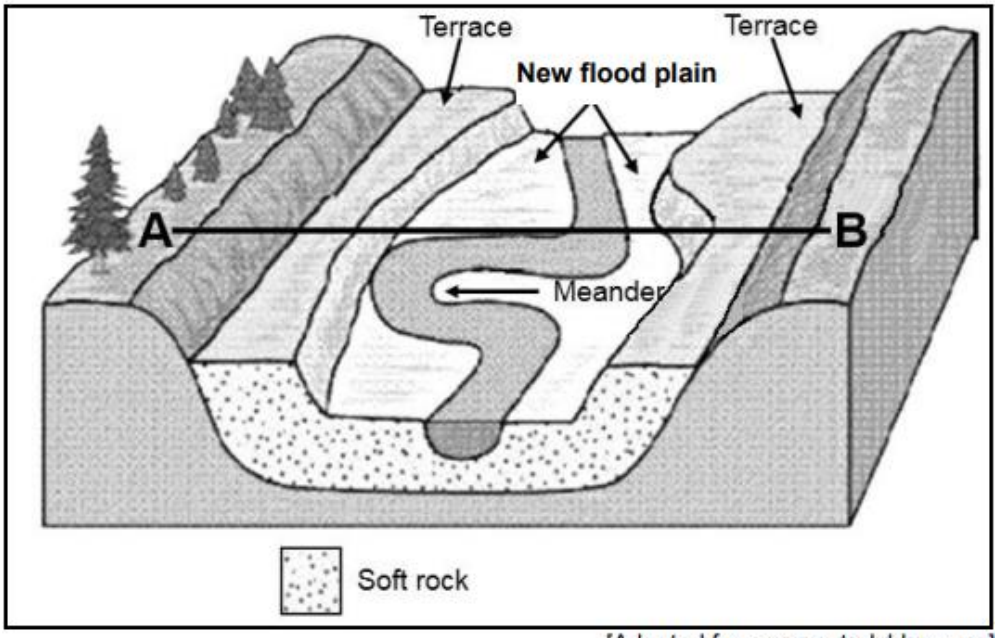
11.1.3 What is a waterfall? (2x1) (2)

11.1.4 Match **Y** and **Z** in sketch **A** with the concepts resistant (hard) rock and less resistant (soft) rock. (2x1) (2)

11.1.5 How does erosion in sketch **B** cause the waterfall to retreat (move) upstream? (3x2) (6)

Activity 12

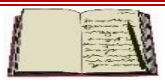
Refer to the sketch below on river rejuvenation.

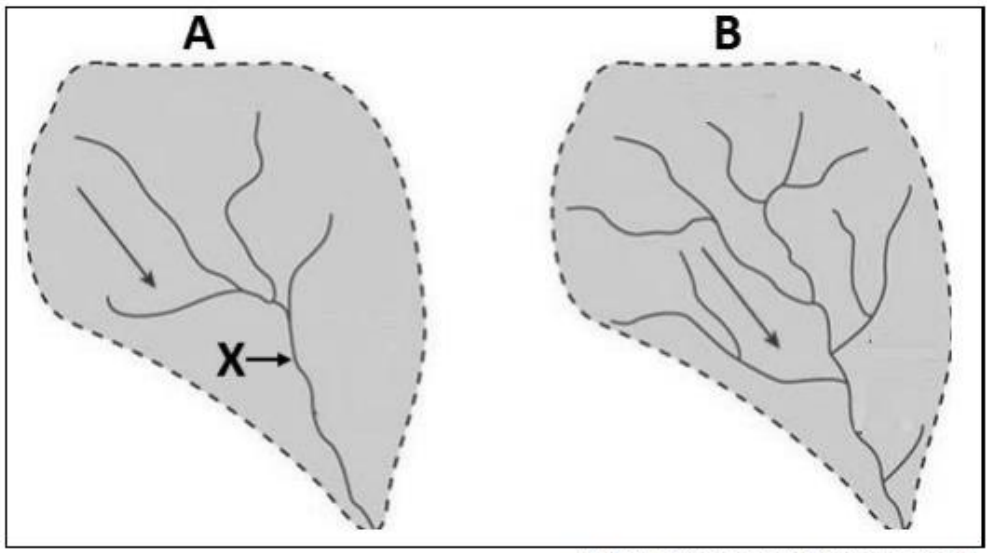


[Adapted from www.studyblue.com]

12.1.1	What is river rejuvenation?	(1x1)	(1)
12.1.2	State TWO possible causes of river rejuvenation.	(2x1)	(2)
12.1.3	Draw a labelled free-hand cross-section from **A** to **B** of the illustrated river rejuvenation. Marks will be allocated for: Shape of the rejuvenated valley Indication of the new flood plain Indication of terraces	(4x1)	(4)
12.1.4	How did the river terraces (illustrated in the sketch) form?	(1x2)	(2)
12.1.5	Explain how the illustrated landscape will negatively impact on infrastructure development.	(2x2)	(4)

Activity 13



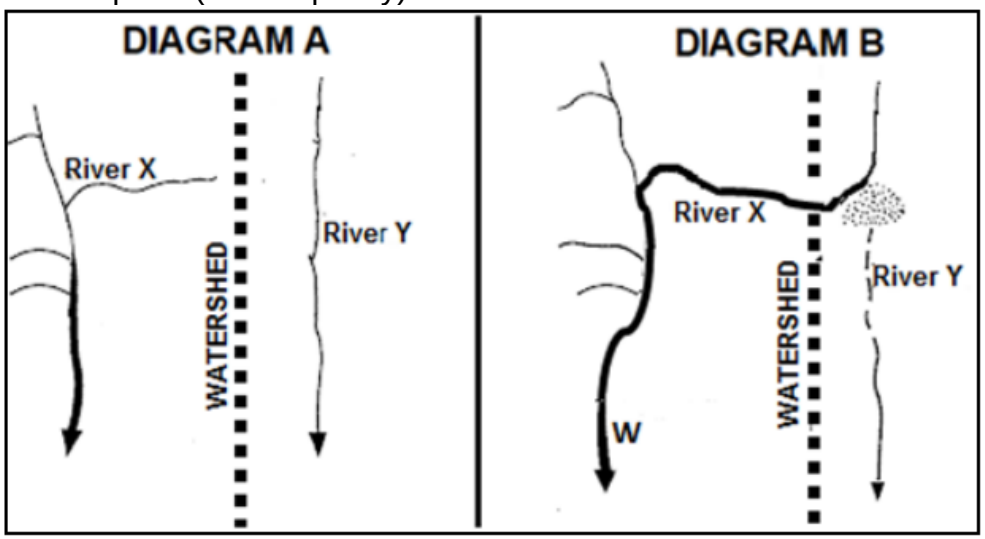


[Adapted from www.civiltee.hu.com]

13.1.1	Define the concept drainage density.	(1x1)	(1)
13.1.2	State the difference in drainage density of drainage basins **A** and **B**.	(2x1)	(2)
13.1.3	How did rock permeability influence the drainage density of drainage basin A?	(2x1)	(2)
13.1.4	Determine the stream order of the river system in drainage basin **A** at point **X**.	(1x2)	(2)
13.1.5	Describe the relationship between drainage density and stream order of a river by referring to drainage basins **A** and **B**.	(2x2)	(4)
13.1.6	Explain how the following influences the drainage density in drainage basin **B**:		
	a. Steep gradient	(1x2)	(2)
	b. Increase in precipitation	(1x2)	(2)

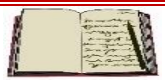
Activity 14

River capture (stream piracy).



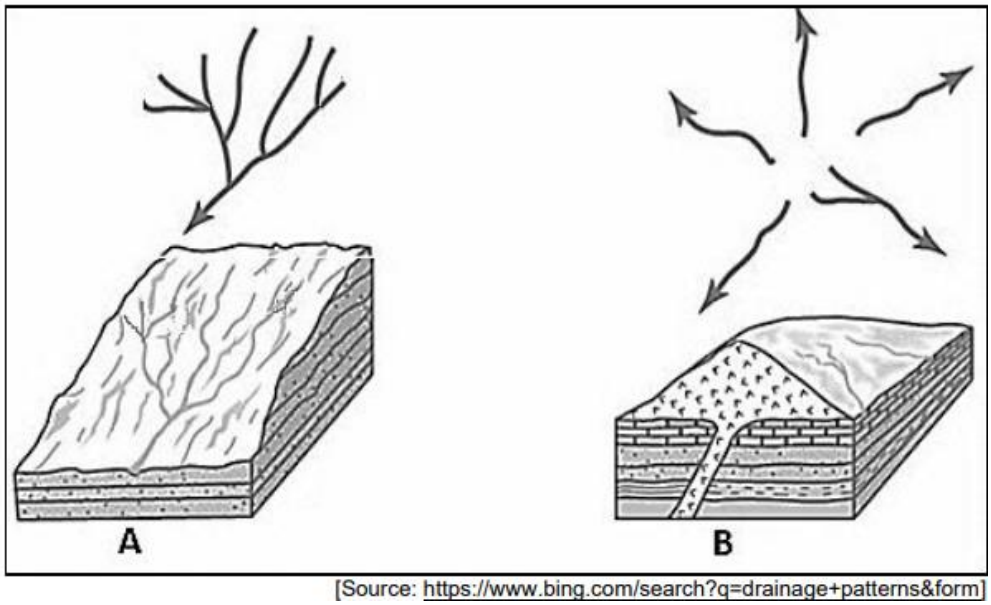
[Adapted from https://www.google.com/search?sxsrf=ALeKk03lP8i1JV-ib25usPsiaZj8KuPD4g:1613590555668&source=univ&tbm=isch&q=river+capture+diagram&sa]

Activity 15



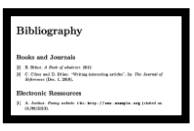
Drainage patterns.

14.1.1	Is river **X** or **Y** the captured river?	(1x1)	(1)
14.1.2	Give TWO pieces of evidence in diagram **B** that shows that river capture has taken place.	(2x1)	(2)
14.1.3	What influence does the underlying rock have on river capture?	(2x1)	(2)
14.1.4	How does river capture rejuvenate the captor stream?	(1x2)	2)
14.1.5	In a paragraph of approximately EIGHT lines, discuss how river capture will have a positive impact on farming at **W**	(4x2)	(8)



[Source: https://www.bing.com/search?q=drainage+patterns&form]

15.1.1	Define the concept drainage pattern.	(1x1)	(1)
15.1.2	Identify drainage patterns **A** and **B**.	(2x1)	(2)
15.1.3	Give TWO characteristics of drainage pattern **A** evident in FIGURE 15.1.3.	(2x1)	(2)
15.1.4	How does the volcanic landscape in FIGURE 15 result in drainage pattern **B**?	(1x2)	2)
15.1.5	Why is drainage pattern **A** more suitable for settlements?	(2x2)	(4)
15.1.6	Explain how the characteristics of the underlying rock structure result in the formation of drainage patterns **A** and **B**	(2x2)	(4)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