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GRADE 12

Geography

SELF STUDY GUIDE

CLIMATE AND WEATHER

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1. INTRODUCTION

The declaration of COVID-19 as a global pandemic by the World Health Organisation led to the disruption of effective teaching and learning in many schools in South Africa. The majority of learners in various grades spent less time in class due to the phased-in approach and rotational/ alternate attendance system that was implemented by various provinces. Consequently, the majority of schools were not able to complete all the relevant content designed for specific grades in accordance with the Curriculum and Assessment Policy Statements in most subjects.

As part of mitigating against the impact of COVID-19 on the current Grade 12, the Department of Basic Education (DBE) worked in collaboration with subject specialists from various Provincial Education Departments (PEDs) developed this Self-Study Guide. The Study Guide covers those topics, skills and concepts that are located in Grade 12, that are critical to lay the foundation for Grade 12. The main aim is to close the pre-existing content gaps in order to strengthen the mastery of subject knowledge in Grade 12. More importantly, the Study Guide will engender the attitudes in the learners to learning independently while mastering the core cross-cutting concepts.

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2. HOW TO USE THIS SELF STUDY GUIDE?

This Self-Study Guide only covers the section on **Climate and Weather of South Africa**. The booklet is designed to explain concepts that seem to be challenging to learners in the Grade 12 Examinations. The first part focuses on the **examination structure** for **Paper 1 and Paper 2**, followed by explanation of the most common **action verbs** used in the question paper and how learners should manage their time. The second part focuses on the selected **key concepts** with their **explanatory notes**, followed by assessment activities designed from previous **examination question papers**. The guide also provides relevant answers and guide learners on how to use a mark allocation (on a question) in order to determine the extent of your response. Mapwork has been integrated in all the relevant sections to follow the new Examination structure.

The guide should be used in conjunction with other resources such as DBE approved textbooks, 2021 Examination Guidelines and Geography CAPS document.

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3. EXAMINATION STRUCTURE

3.1 PAPER 1

3.1.1 This is a 3-hour question paper which is written on a SEPARATE DAY from Paper 2.

3.1.2 The mark allocation for this paper is 150.

3.1.3 The question paper consists of two sections, namely SECTION A and SECTION B:
SECTION A: Climate and Weather and Geomorphology (Theory)
SECTION B: Geographical Skills, Techniques, Application and Interpretation and GIS (Map work)

3.1.4 SECTION A consists of **TWO** questions of 60 marks each.
SECTION B consists of **ONE** question of 30 marks.

3.1.5 All the **THREE** questions are compulsory.

3.2 PAPER 2

3.2.1 This is a 3-hour question paper which is written on a SEPARATE DAY from Paper 1.

3.2.2 The mark allocation for this paper is 150.

3.2.3 The question paper consists of two sections, namely SECTION A and SECTION B:
SECTION A: Settlement and Economic Geography of South Africa (Theory)
SECTION B: Mapwork- Geographical Skills and Techniques (Map work)

3.2.4 SECTION A consists of **TWO** questions of 60 marks each.
SECTION B consists of **ONE** question of 30 marks.

3.2.5 All the **THREE** questions are compulsory.

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4. EXAMINATION TIPS

TYPES OF QUESTIONS

The types of questions in both Paper 1 and Paper 2 are as follows:

4.1 Short objective questions:

✓ Multiple-choice:

- Know what each multiple-choice question is asking.
- Evaluate each answer to the multiple-choice question.
- Eliminate each answer that is clearly wrong.
- Do not leave any question unanswered.

✓ Matching:

- Know the definitions/explanations of concepts for each section as you will be required to pair each item with the correct terminology provided.
- These questions assess recognition and recall of knowledge acquired.

4.2 Data response questions

- With a data response question, you are required to interpret diagrams, maps, photos, tables, statistics, cartoons, etc.
- Data response questions require knowledge, application analysis and evaluation.
- Marks for data response questions range from 2-8 marks.

4.3 Paragraph-type questions

Paragraph assess communication skills, knowledge and insight. These questions require critical and analytical thinking. In order to master these questions, learners should:

- underline the **main topic** of the question,
- underline the **action words** or **question verbs**,
- underline the **focus areas** of the question (note that most paragraph questions might require two aspects or issues that must be discussed/ explained in two equal parts),
- write in **full sentences** to explain answers, and
- avoid repetition of facts.

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An illustration of how to analyse a paragraph question statement:

Action verb: What to do?

Issue 1: Increased food cost

Explain, in a paragraph of approximately EIGHT lines, why the cost of food and electricity could increase in future if pollution of the Vaal River is not controlled.

(4 x 2) (8)

Issue 2: Increased electricity cost

Main topic

The cost of food will increase because the polluted water will be expensive to purify so that it could be used in agriculture. Farmers will have to buy more chemicals to purify the water. If not, they will have to buy purified water from other service providers at a costly price. This will have a negative impact on production costs in agriculture, leading to increased food prices. Furthermore, polluted water reduces soil fertility which could lead to crop failure. This could lead to food being imported from other countries at very expensive prices in order to prevent food insecurity in the country. Polluted water will be expensive to purify so as to generate hydro-electricity, thereby causing Eskom to inflate electricity prices. Increased production costs will increase electricity costs. Less production of electricity due to river pollution will increase demand and supply, making electricity costs expensive. (4 x 2) (8)

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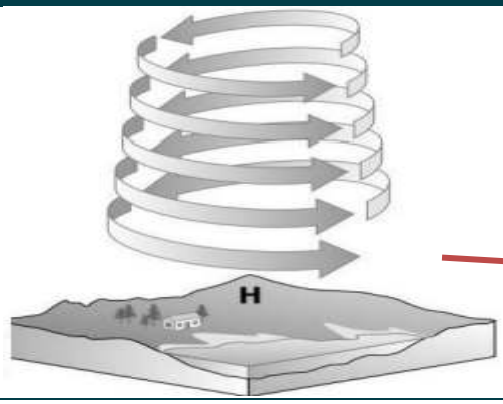
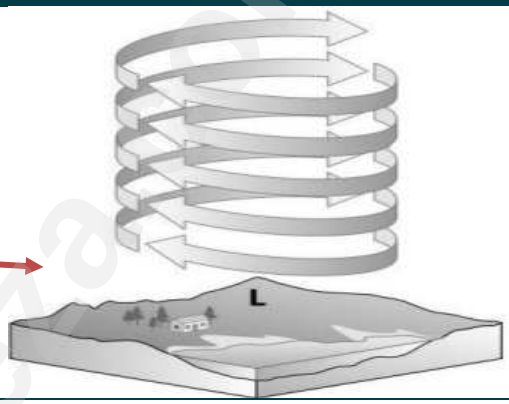
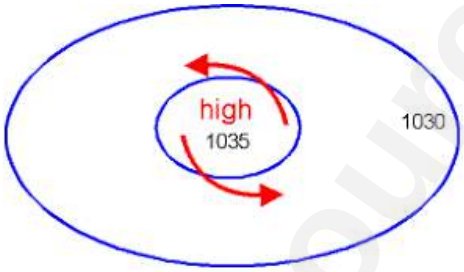
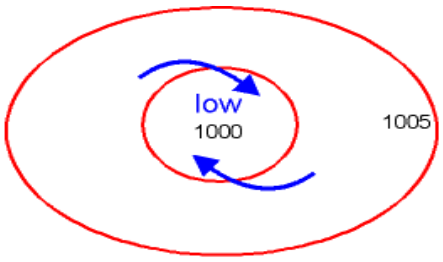
5. REVISION: GRADE 10 AND 11

HIGH- AND LOW-PRESSURE CELL (Grade 10)
Importance of High- and Low-pressure Cells:
The unequal heating of the atmosphere results in the development of high- and low-pressure cells. It is important that you know the characteristics of High- and Low-pressure cells

	High pressure cell	Low pressure cell
Cross section		
Plan view		
Characteristics	• Air subsides (decends) • Air diverges at the centre • Clear/dry skies • No release of latent heat • No cloud formation • **Oval** shaped isobars • Air circulates in an **anticlockwise rotation** • **Isobar values increase** towards the centre of the high pressure • Also called an **Anticyclones** • **Forms:** - South Atlantic Anticyclone - South Indian Anticyclone - Kalahari Anticyclone	• Air ascends (rises) • Air converges at the centre • Condesation takes place • Latent heat is released during condensation • Clouds form and precipitation occurs • **Circular** shaped isobars • Air circulates in a **clockwise rotation** • Also known as a **cyclone** • **Isobar values decrease** towards the centre of the low pressure • Also called a **Cyclone** • **Forms:** - Coastal low - Mid-Latitude cyclones - Tropical cyclones

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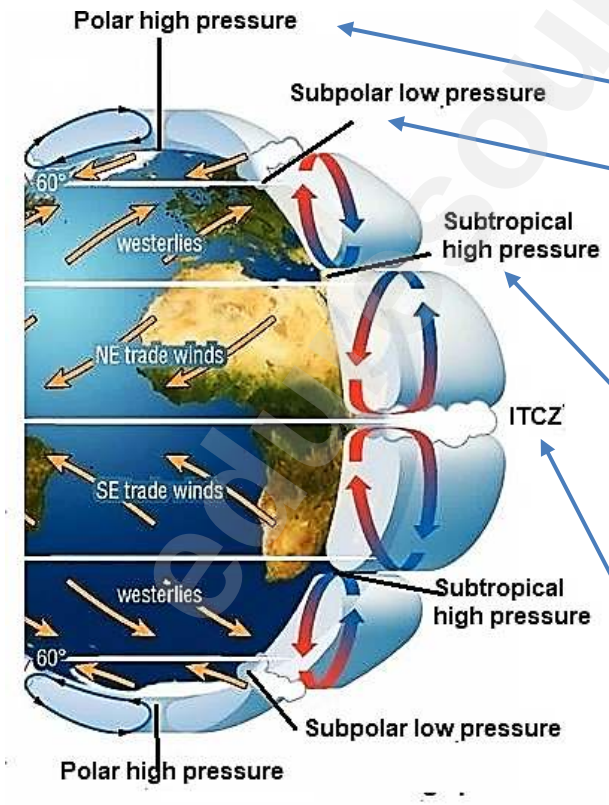
WORLD PRESSURE BELTS (Grade 11)

Importance of the Pressure belts:
The development of High- and Low-pressure cells results in the development of the pressure belts at different latitudes because of pressure gradient and Coriolis force that have an impact on the global circulation of the atmosphere.



Source: https://www.40knots.net/what-are-the-trade-winds/

Pressure belts	Caracteristics of the Pressure belts
Polar high at 90° N and S	• Associated with cold, dense air which subsides over the poles. • Stable, clear and cold • conditions prevail
Sub-polar Low at 60° N and S	• A region of low pressure associated with the convergence of two different air masses. • The air is forced to rise. • This creates a low-pressure area. • Also called the polar front and this is where **mid-latitude cyclones** originate.
Sub-tropical High at 30 °N and S	• A region of high pressure associated with subsiding air • The descending air is warm and dry. • Deserts form in these regions. • Associated with clear skies and low rainfall. • A region of high pressure associated with subsiding air. • Associated with clear skies and low rainfall.
Equatorial low at 0°	• Also called the inter-tropical convergence zone (ITCZ) where maximum heating takes place. • Hot air rises creating a low-pressure area at the surface. • The rising air is moisture laden. • Associated with convergence thunderstorms and high rainfall. • Confluence of NE trade winds and SE trade winds at 5° North and South results in the development of **Tropical cyclones**.

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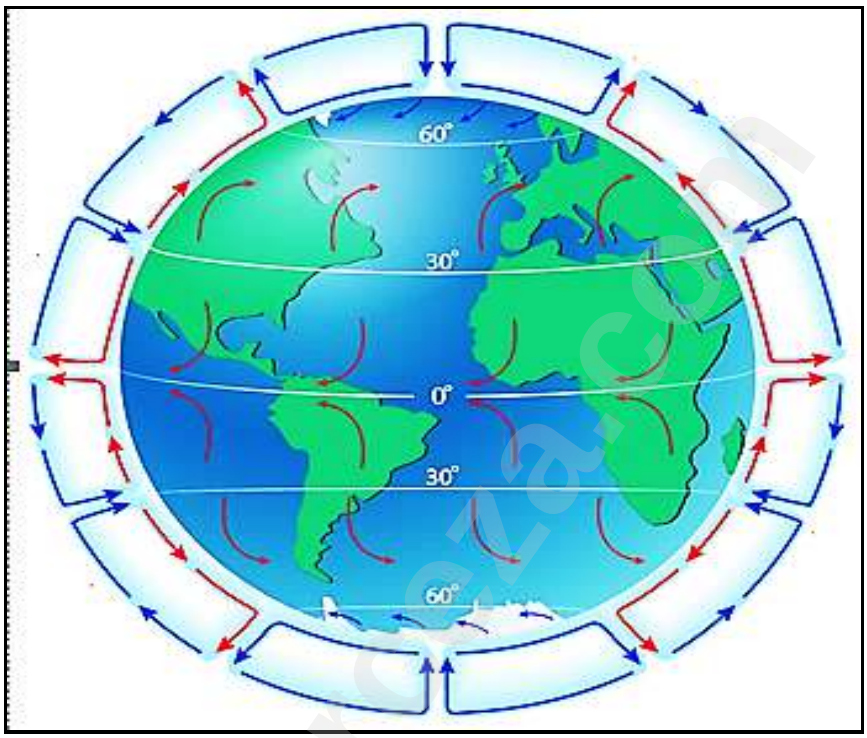
ACTIVITY 5.1: GRADE 11 REVISION

5.1 Study FIGURE 5.1, the world map showing Global Air Circulation and identify the following features.



[Source: https://www.internetgeography.net/topics/what-is-global-atmospheric-circulation/

5.1.1 Name the pressure cell that develops at 90º N and S. (1)

5.1.2 The surface wind which develops between the 30º and 60º North and South. (1)

5.1.3 The pressure belt that would dominates the 30º North and South latitude. (1)

5.1.4 Identify the surface wind that will be experienced between the 90º and 60º North and South latitudes. (1)

5.1.5 What is another name for the 0º latitude area? (1)

5.1.6 Name the pressure cell that develops at 60º N and S. (1)

5.1.7 Identify the surface wind that will be experienced between the 30º and 0º North and South latitudes. (1)

(7 x 1) (7)

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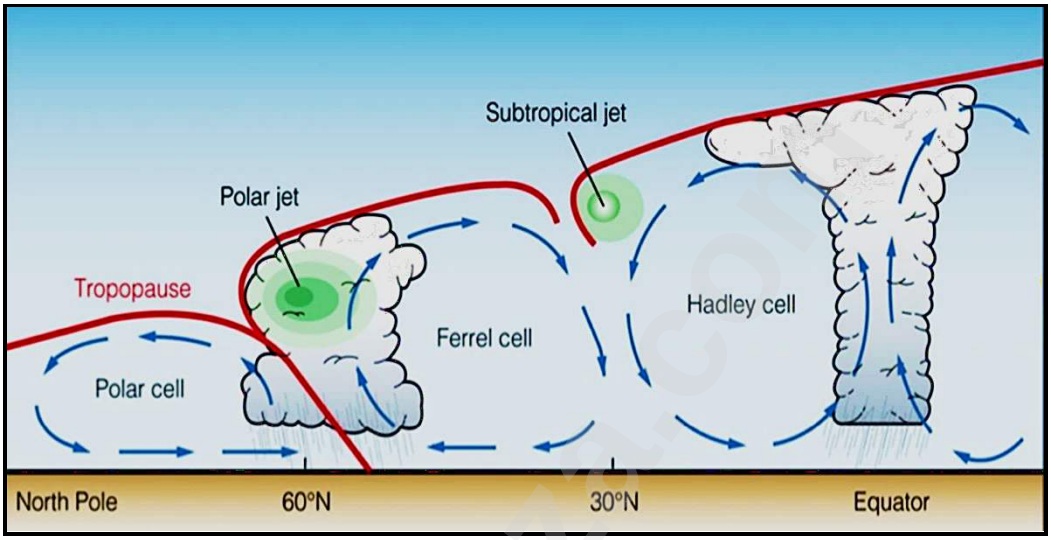
ACTIVITY 5.2: GRADE 11 REVISION

5.2 Study FIGURE 5.2 and answer the questions that follow by choosing the appropriate word/phrase from the text box.



[Source: http://geophile.net/Lessons/atmosphere/atm_circulation_05.html]

High, Low, Warm, Cold, Diverge, Pressure Cells, Rise, Polar Easterlies, Converge

5.2.1 In the Polar Cell there is a … pressure. (1)

5.2.2 In the Polar Cell air sinks because it is … (1)

5.2.3 Winds in the Polar Cell … in the upper atmosphere. (1)

5.2.4 The winds in the Ferrel Cell … on the surface. (1)

5.2.5 Winds converge and … at the equator. (1)

5.2.6 The Hadley Cell is associated with … pressure. (1)

5.2.7 Air rises in the Hadley Cell because it is … (1)

(7 x 1) (7)

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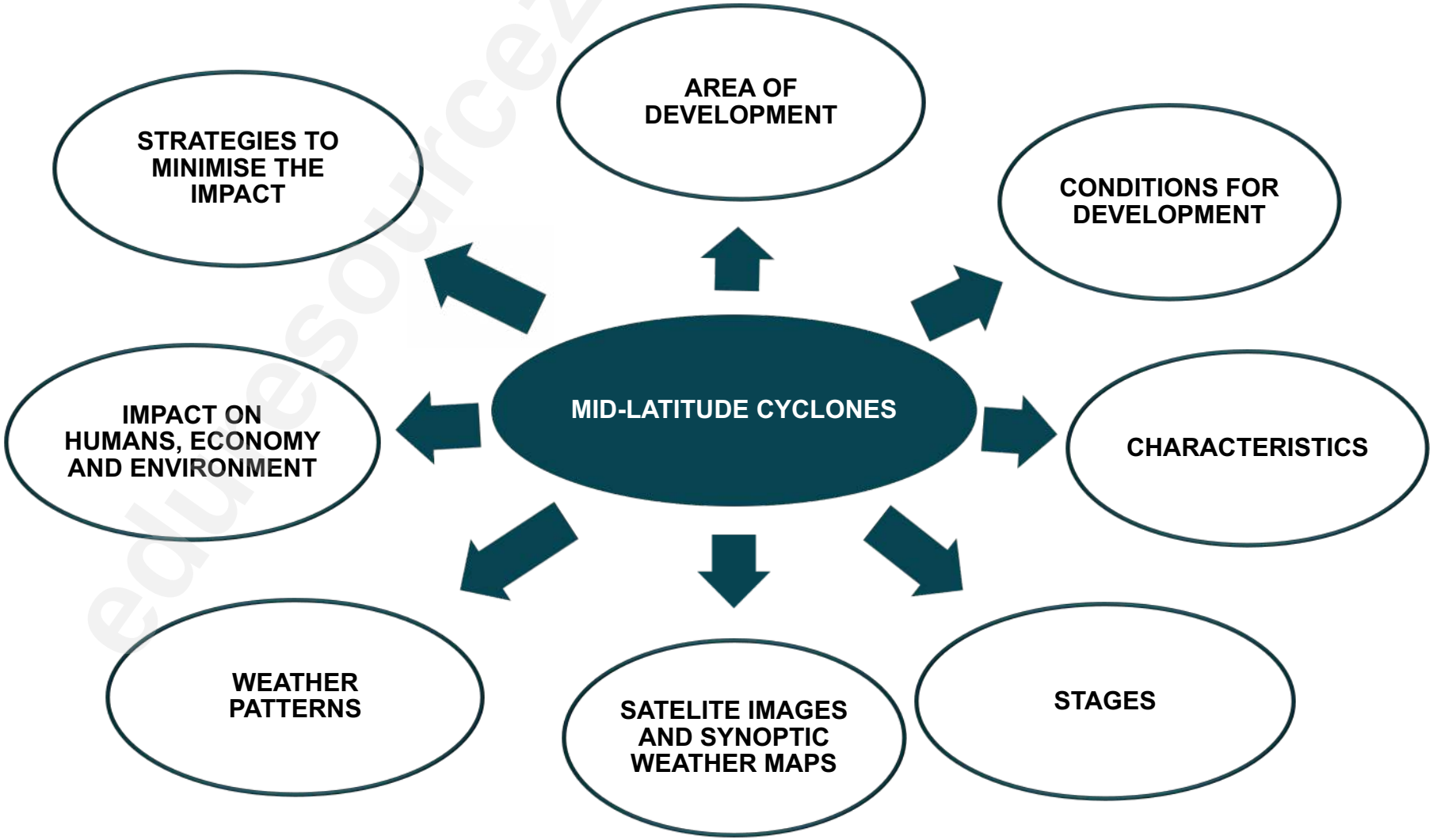
6. MID-LATITUDE CYCLONES



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A. KEY CONCEPTS: MID-LATITUDE CYCLONES

Term	Explanation
Air mass	A huge mass of air, extending for hundreds of kilometres, with similar temperature and humidity
Backing	The anticlockwise change in wind direction that occurs as a mid-latitude cyclone passes over.
Cold front	The leading edge of a cold air mass of a mid-latitude cyclone.
Cold front occlusion	An occlusion where the overtaking cold air is colder than the cold air ahead of it. The overtaking cold front lifts warm air off the ground.
Cold sector	The mass of colder air behind the cold front in a mid-latitude cyclone.
Cyclogenesis	The development and strengthening of a mid-latitude and Tropical cyclone.
Front	The boundary separating two air masses with different densities.
ITCZ	The Inter Tropical Convergence Zone; an area where the tropical easterlies converge.
Jet stream:	A band of very strong westerly winds high in the atmosphere (troposphere) which partly controls the development of mid-latitude cyclones.
Mid-latitude cyclone	A large, low-pressure weather system made up of warm and cold fronts; also called an extra-tropical cyclone, temperate depression or frontal depression.
Occluded front	A front formed when a cold front overtakes and replaces a warm air mass.
Occlusion	The decaying stage in the development of a mid-latitude cyclone where the cold front to the rear catches up with the leading warm front, lifts the warm air off the ground and meets the cold air ahead of the warm front.
Polar front	Zone separating the cold polar air (easterlies) and warm tropical air (westerlies).
Veering wind	The shift of wind in a clockwise direction over time at a specific location, for example from a southerly to south easterly.
Warm front	The leading edge of a warm air mass.
Warm front occlusion	An occlusion where the overtaking cold air is warmer than the cold air ahead of it.
Warm sector	The warm air behind the warm front of a mid-latitude cyclone.

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B. NOTES/SUMMARIES ON MID-LATITUDE CYCLONES

AREA OF DEVELOPMENT

- Located in the middle or temperate latitudes
- Between latitudes 30° - 60° north and south of the equator.
- Forms at the polar front where warm westerlies and cold polar easterlies meet

OTHER NAMES

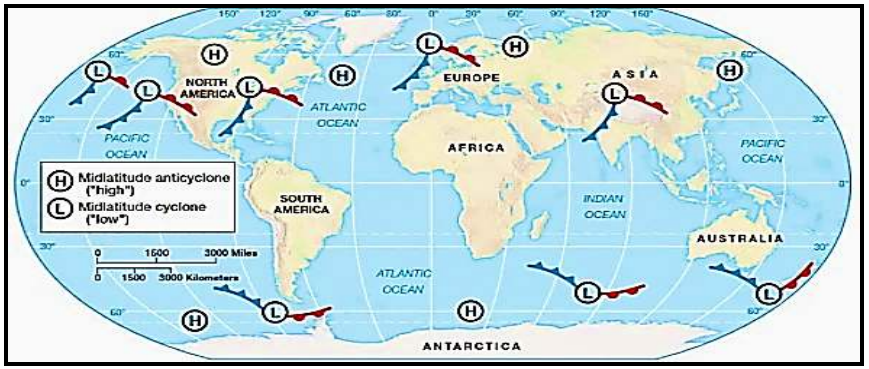
- Moderate Cyclone
- Extratropical Cyclone
- Temperate Cyclone
- Frontal depression

CONDITIONS NECESSARY FOR DEVELOPMENT

- Cold polar air mass from cold polar easterlies and warm tropical air from warm westerly winds, meet.
- Cause an imbalance in energy distribution because of difference in temperature.
- Differences in wind patterns(direction) contribute to resultant formation.

MORE PROMINENT IN WINTER OVER SOUTH AFRICA

The northward migration of the ITCZ and with it the migration of the high-pressure cells, results in the low-pressure systems moving over Southern part of South Africa.



[Source: https://lotusarise.com/temperate-cyclone-extratropical-cyclone-upsc/]

CHARACTERISTICS

- Extensive low-pressure in center of the system.
- Clockwise movement of air in Mid-Latitude Cyclone in Southern Hemisphere.
- Presence of a cold front.
- Cold sector (Area of cold air behind cold front).
- Presence of a warm front.
- Warm sector (Area of warm air behind warm front).
- Isobar pattern is oval.
- Moves from west to east because its driven by stronger westerly winds
- Affects the Western side of continents in the middle latitudes.
- Diameters are between 1 500 and 3 000km.
- Travels at a speed of about 50 – 60 km per hour.
- Lifespan of system is between 4 and 14 days.
- They usually occur in families (two or more).
- Forms all year but better developed in winter from April to October in South Africa.

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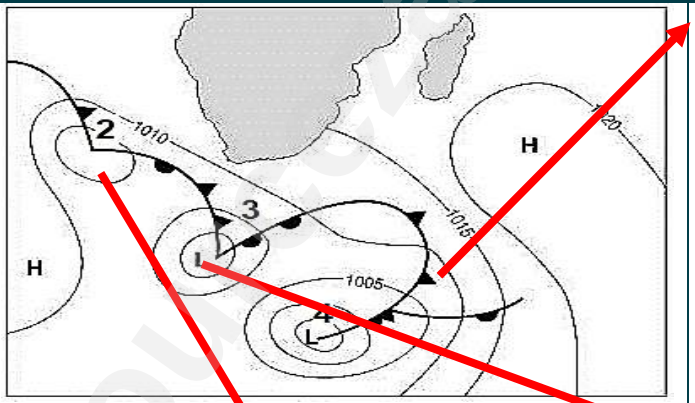
STAGES OF DEVELOPMENT OF A MID-LATITUDE CYCLONE

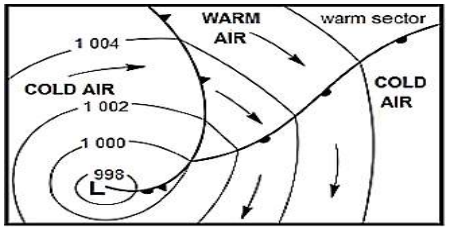
FOUR STAGES

1. Initial stage
2. Development stage
3. Mature stage
4. Occluded stage



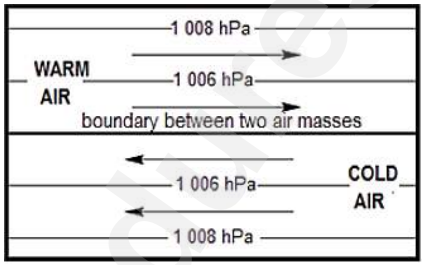
[Source: wcedonline.westerncape.gove.za]

4. OCCLUDED STAGE



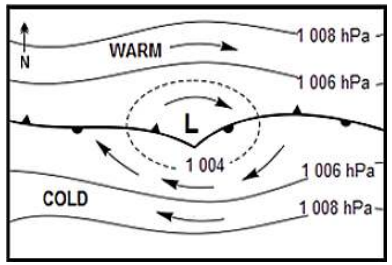
- Warm sector continues to narrow.
- Cold front overtakes the warm front cold air wedges in under warm air.
- The warm air then becomes isolated from the ground.
- This is called an occlusion.

1. INITIAL STAGE



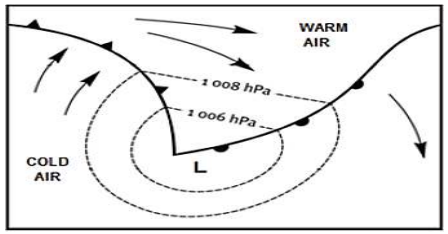
- The Polar front is stationary.
- Warm westerly and cold polar easterlies. blow in opposite directions along the polar front.
- The different air masses do not have the same density, temperature, and humidity.
- Therefore, they do not mix.
- Friction develops between the air masses.

2. DEVELOPMENT STAGE



- A wave develops in the polar front.
- A small mass of warm air extends into the cold air and rises.
- This rising air cause a low pressure in the centre.

3. MATURE STAGE



- The low pressure intensifies.
- It moves into the westerly wind belt away from the polar front.
- A well-developed cold and warm sector develops.
- Cold dense air moves faster and forces the light humid less dense air in the warm sector to rise.
- The cold sector becomes larger than the warm sector as the cold air moves and lifts the warm air.

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TWO TYPES OF OCCLUSIONS:

COLD FRONT OCCLUSION:

- Air ahead of the cold front is slightly warmer than the air behind the cold front.
- This causes the warm air in front to be uplifted along the cold front.
- Rising air cools, condensation takes place and forms nimbostratus clouds.
- This results in rain.

Cold occluded front

[Source: https://slidetodoc.com/air-masses-and-fronts-ii-brief-review-an/]

WARM FRONT OCCLUSION:

- Air ahead of the cold front is colder than the air behind the cold front.
- This results in the air behind the cold front and the warm air in warm sector, rising over the cold air in the front.
- Rising air cools, condensation takes place and forms nimbostratus clouds.
- This results in rain.

Warm occluded front

[Source: https://slidetodoc.com/air-masses-and-fronts-ii-brief-review-an/]

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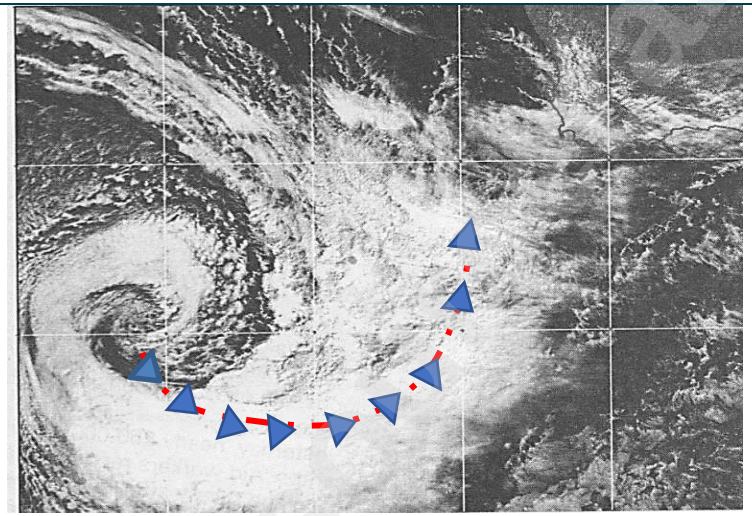
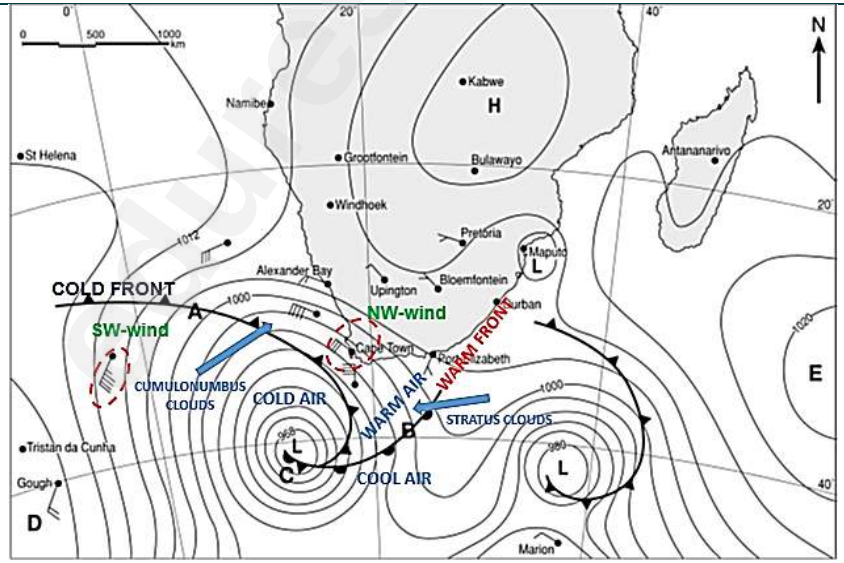
THE APPEARANCE OF MID-LATITUDE CYCLONES ON SATELLITE IMAGES AND SYNOPTIC WEATHER MAPS

SATELLITE IMAGE

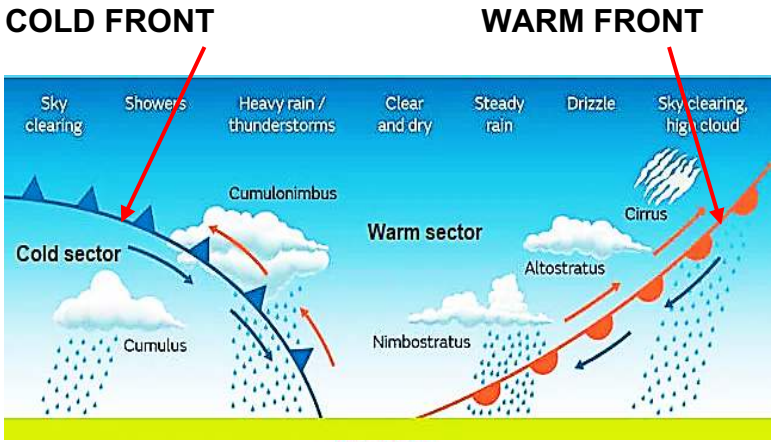


SYNOPTIC WEATHER MAP

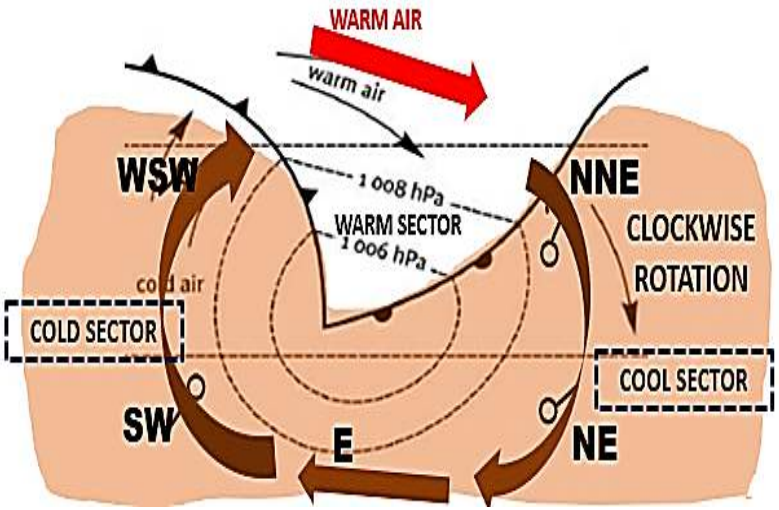


[Source:Adapted from https://www.futurelearn.com/info/courses/learn-about-weather/0/steps/28922

CROSS-SECTION



TOP VIEW / PLAN VIEW



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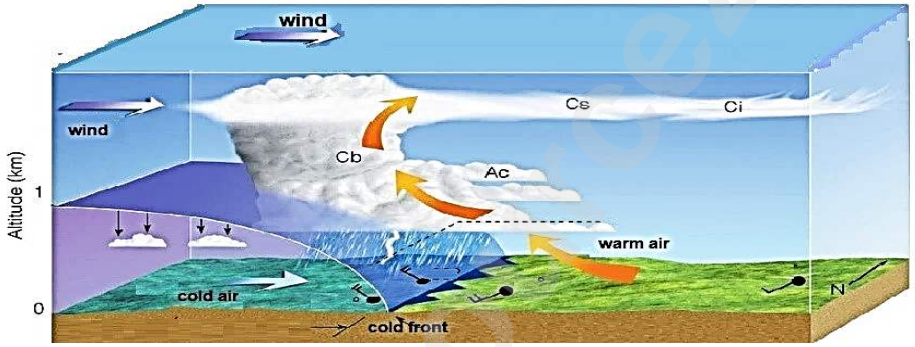
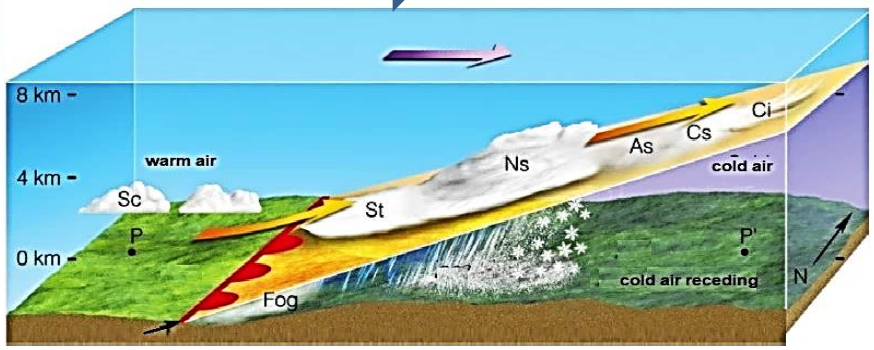
ASSOCIATED WEATHER PATTERNS

COLD FRONT → **WARM FRONT**





[Source: https://apollo.nvu.vsc.edu/classes/met130/notes/chapter11/cf_xsect.html]

WEATHER	COLD SECTOR	COLD FRONT	WARM SECTOR	WARM FRONT	CYCLONE APPROACHING
Air pressure	Increase slowly	Sudden increase	Remains steady	Decrease stops	Steady decrease
Wind direction	South	Backing from west to south	West	Backing from north-west to west	Northwest
Wind speed	Gusty, decrease slowly	Very strong to gale force	Decrease	Strong	Increase slowly
Temperature	Cold, around 5 °C	Sudden decrease	Warm to mild, around 12 °C	Sudden rise	Cool, around 8 °C
Relative humidity	Rapid fall	High during precipitation	Steady and high	High during precipitation	Slow rise
Cloud cover	Decreasing in succession to cumulus	Very thick and towering/vertical cumulonimbus	Low stratus clouds with clear patches in between	Low and thick nimbostratus	High and thinner clouds altostratus, cirrostratus and cirrus
Precipitation	Heavy and later soft, persistent showers	Short period of heavy rain and hail	Intermittent drizzle or stop	Continuous rainfall – steady and quite heavy	None
Visibility	Very good, but poor during showers	Poor, especially during showers and fog	Often poor	Decrease rapidly	Good, but decreasing with nearing front

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REASONS FOR WEATHER CHANGES IN COLD FRONT

CHANGE	COLD FRONT	REASON
Temperature	Decrease	Cold air behind front has arrived.
Wind	"backs" becomes SW	Clockwise rotation from air around the low pressure.
Cloud cover	Increases	Warm air rises over the approaching cold air, cools and condenses.
Cloud type	Cumulonimbus	Cold air forces the warm air to rise rapidly and condensation occurs to great heights.
Pressure	Decrease then increase	Pressure at its lowest just before cold front then it rises as cold air arrives.
Rainfall	Heavy rainfall over small area	Strong convection taking place and cumulonimbus clouds.

IMPACT OF MID-LATITUDE CYCLONE ON HUMANS, ECONOMY AND ENVIRONMENT

	HUMANS	ENVIRONMENT	ECONOMY
POSITIVE	• Winter rainfall determined type of crops that are cultivated. • Rain replenish water in dams. • Snow in mountains replenish water when it melts.	• Winter rainfall that is necessary for winter crops. • Production of winter crops results in food security.	• Production of winter crops benefits the GDP.
NEGATIVE	• Snow that falls is dangerous for people. • Extreme cold can result in power cuts and disruption of human activities. • Berg winds that develop in warm sector is hot and dry and can encourage the spread of veld fires. • Gale force winds behind cold front results in stormy conditions over ocean and is a danger to ships. • Heavy rain from cold front leads to poor visibility and traffic accidents. • Mountain passes may be closed if there is snow.	• Snow that falls is dangerous for livestock. • Extreme cold damage crops and livestock. • Berg winds damage vegetation because of dry warm conditions. • Gale force winds damage crops. • Heavy rain cause floods which is negative for crops and livestock.	• Expensive for farmers to protect crops and livestock. • Floods can damage crops and impact the economy negative.

STRATEGIES TO MINIMISE THE IMPACT OF MID-LATITUDE CYCLONES

• 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.

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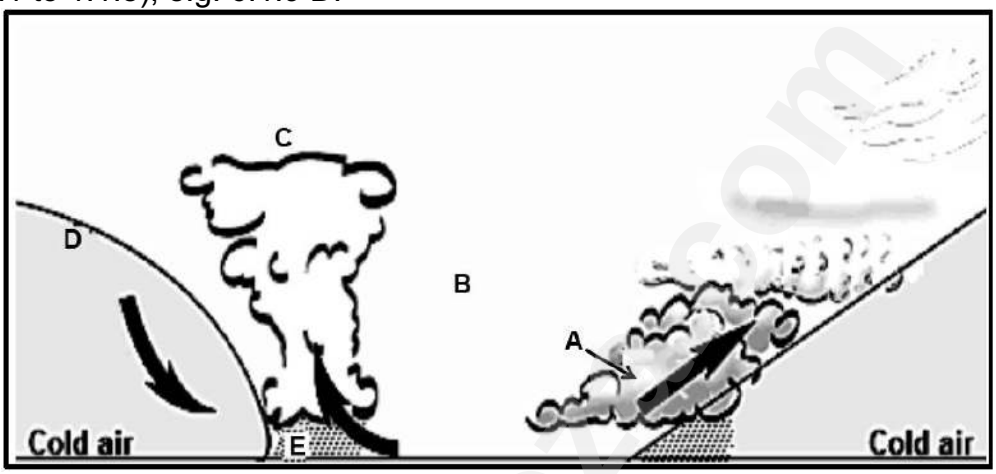
ACTIVITY 6.1: MID-LATITUDE CYCLONE

6.1 Various options are provided as possible answers to the following questions based on the cross-section of the mid-latitude cyclone in FIGURE 6.1. Choose the answer and write down only the letter (A–D) next to the question numbers (6.1.1 to 1.1.8), e.g. 6.1.9 D.



[Source: DBE Paper 1 November 2019]

6.1.1 The general direction of movement of the mid-latitude cyclone in the Southern Hemisphere is … -wards.

A north
B west
C east
D south

6.1.2 Identify cloud **A** that is associated with the warm front.

A Stratus
B Cumulus
C Nimbostratus
D Cumulonimbus

6.1.3 The area at **B** is referred to as the …

A warm sector.
B cold sector.
C polar front.
D apex.

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6.1.4 The type of cloud at **C** is …

A stratus.
B cirrus.
C cumulonimbus.
D nimbostratus.

6.1.5 The gradient at **D** can be described as …

A steep.
B gentle.
C weak.
D vertical.

6.1.6 The … front is found at **D**.

A polar.
B cold.
C occlusion.
D warm.

6.1.7 The more active and faster moving front is the … front.

A polar
B cold
C warm
D moisture

6.1.8 The type of rainfall at **E** is/are …

A light showers.
B frontal rain.
C orographic rain.
D convectional rain.

(8 x 1) (8)

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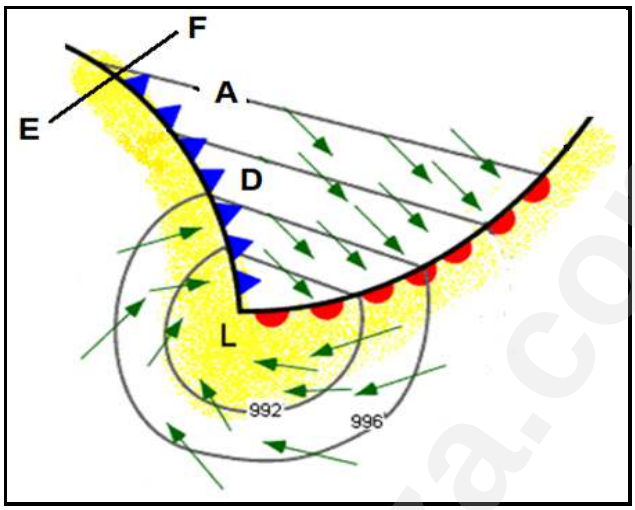
ACTIVITY 6.2: MID-LATITUDE CYCLONE

6.2 Refer to FIGURE 6.2 which shows a mid-latitude cyclone.



[Source: http://lukemweather.blogspot.com/2011/01/something-little-different-look-at.html]

6.2.1 Provide ONE point of evidence visible in FIGURE 6.2 to substantiate that the mid-latitude cyclone shown is in the mature stage of development. (1 x 1) (1)

6.2.2 Which hemisphere is depicted in FIGURE 6.2? (1 x 1) (1)

6.2.3 Draw a transverse profile from **E** to **F** in FIGURE 6.2 and indicate the following:

(a) An arrow indicating the direction of movement of the front.
(b) A label for the cloud type depicted.
(c) The area of cold air.
(d) The area of warm air. (4 x 1) (4)

6.2.4 Account for the likelihood (chance) that expected rainfall at location **A** in FIGURE 6.2 will be gentle. (2 x 2) (4)

6.2.5 An outdoor music festival is planned at location **D** in FIGURE 6.2 in the next 24 hours. Recommend the rescheduling of the event by providing TWO climatological reasons as to how the music festival could be affected by the expected changes in weather that may occur. (2 x 2) (4)

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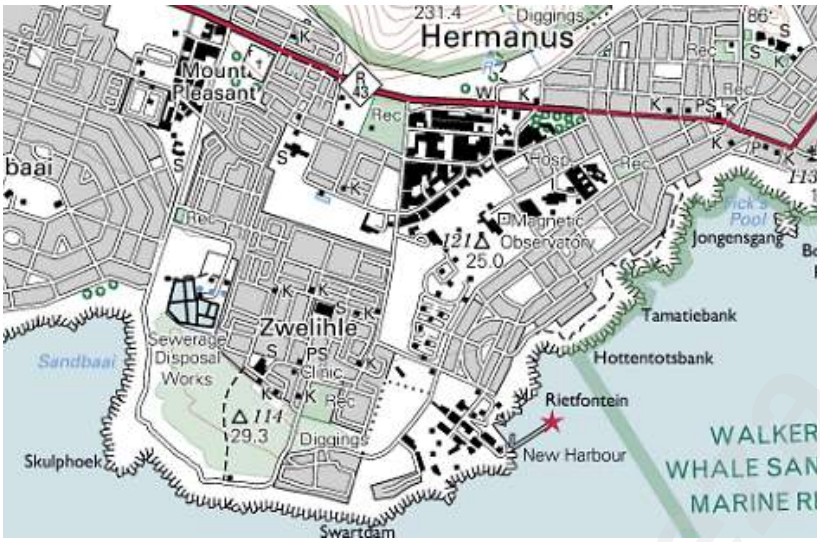
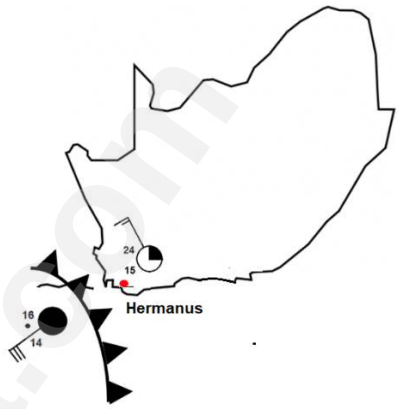
ACTIVITY 6.3: MAP WORK APPLICATION

6.3 Study the extract of the 3419 AC HERMANUS topographic map and the simplified map of South Africa showing an approaching mid-latitude cyclone.



[Source: Extract from 3419 AC HERMANUS]



Source: Glenn Samaai PowerPoint presentation

Tropical cyclones that have hit South Africa |

Tropical cyclones that have hit South Africa According to the South African Weather Services, the effect of tropical cyclones in the country is between January and February. Only tropical cyclones moving into the Mozambique channel influence South Africa's weather.IN PICTURES | 34 years after Cyclone Domoina hit,IN PICTURES | 34 years after Cyclone Domoina hit SA - shocking images of devastation 08 October 2018 - 12:11 By Staff Writer A railway bridge washed away by the cyclone.Some effects of the cyclones Domoina and Imboa,Some effects of the cyclones Domoina and Imboa on mangrove communities in the St Lucia Estuary T.D. Steinke, * C.J. Ward, Estuarine and Marine Group, Department of Botany, University of Durban-Westville, Private Bag X54001, Durban, 4000 Republic of South Africa Estuarine and Marine Group, Department of Botany, University of Durban-Westville Private Bag X54001 Durban 4000 Republic of South,

6.3.1 Predict the direction of movement of the mid-latitude cyclone located South-west of Hermanus. (1 x 1) (1)

6.3.2 In which general direction will fishermen launch their boats from the New Harbour? (1 x 1) (1)

6.3.3 Explain how the approaching mid-latitude cyclone will impact the launching of the fishing boats at Hermanus harbour? (2 x 2) (4)

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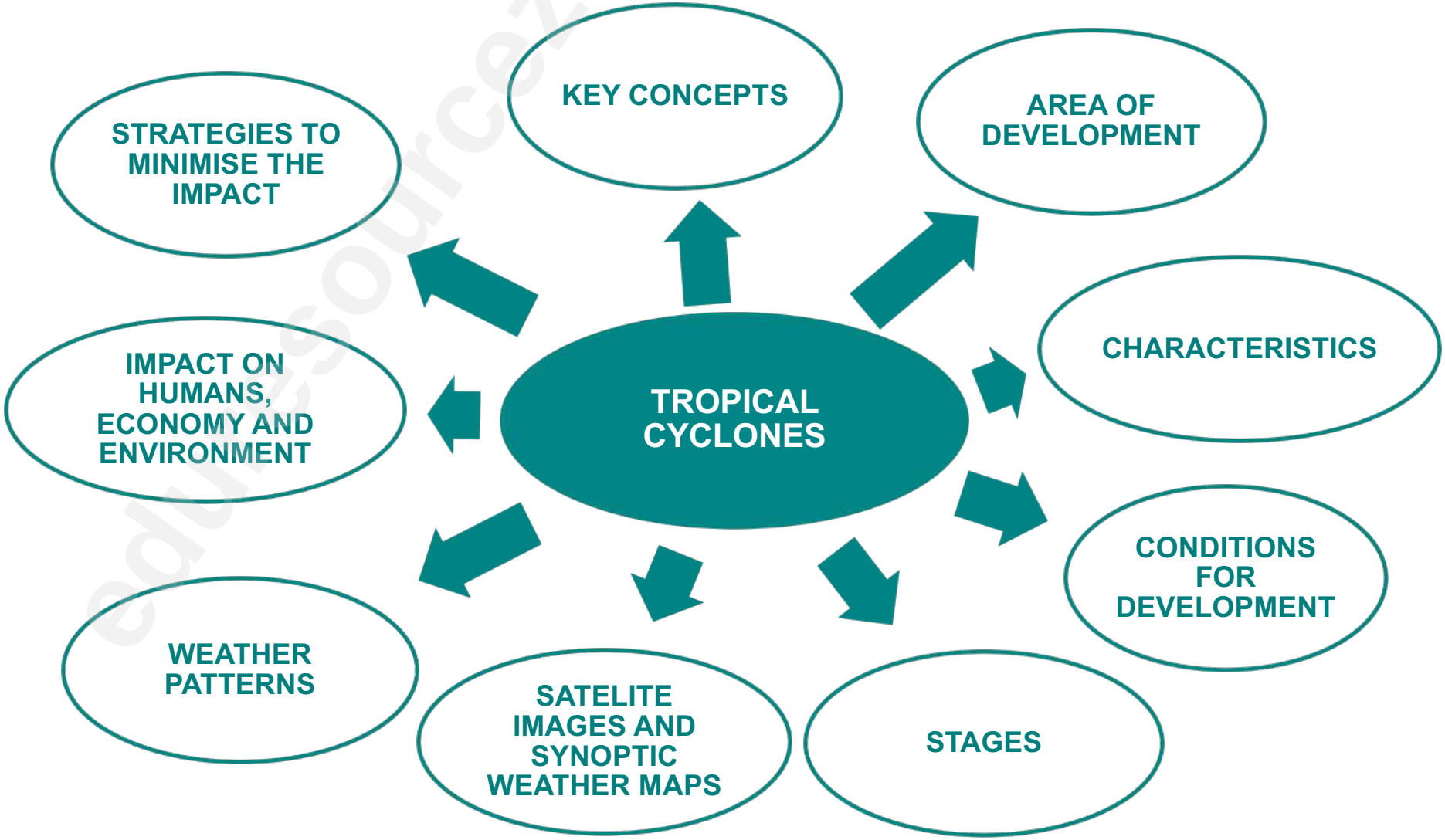
7. TROPICAL CYCLONES



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A. KEY CONCEPTS: TROPICAL CYCLONES

Term	Explanation
Adiabatic heating	Occurs when air descends and compresses, resulting in very little precipitation.
Adiabatic lapse rate	Is the **rate** at which the temperature of an air parcel changes in response to the compression or expansion associated with elevation change, under the assumption that the process is **adiabatic**, i.e., no heat exchange occurs between the given air parcel and its surroundings.
Coriolis force	A force caused by the rotation of the earth which results in the deflection of the winds and ocean currents. Deflection is to the right in the northern and to the left in the southern hemisphere.
Dissipate	Is to break up or disappear or weakening
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 absorbed or released during a phase change of a substance. It could either be from a gas to a liquid or liquid to solid.
Make landfall	The term used to describe the arrival of the eye of a tropical cyclone over the coast.
Storm surge	An abnormal rise of water along the coast associated with a low-pressure system as a tropical cyclone.
Tropical Cyclone:	A powerful, rotating storm system, around a low-pressure cell which develops over a warm ocean between the tropics. the eye moves over land.
Tropical cyclone landfall	A tropical cyclone is classified as making a landfall when the centre of the storm moves across the coast, in strong tropical cyclones.
Vortex	A mass of spinning air that attracts more air to its centre.
Water spout	It is a weak tornado that forms at sea in association with the storm clouds of a tropical cyclone.

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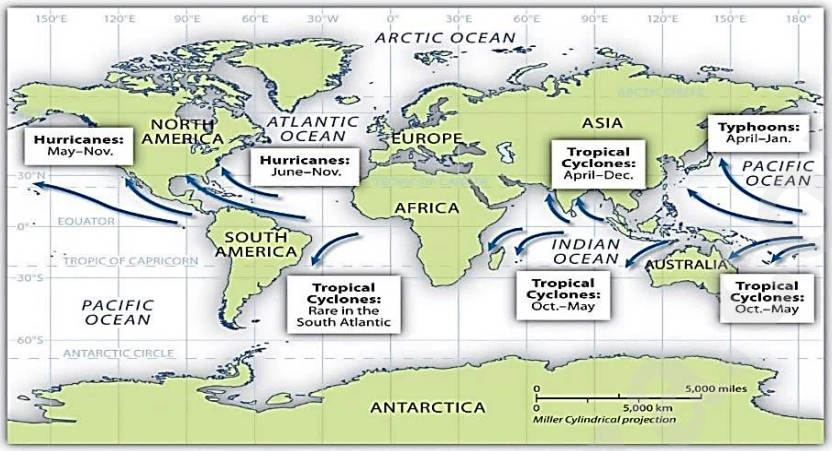
B. NOTES/SUMMARIES ON TROPICAL CYCLONES

Grade 11 Revision:
Refer to pressure belts as indicated in the revision section on the Mid-latitude cyclones. (Page 9)

The diagram below shows the areas where tropical cyclones are found.



[Source: https://www.mapsofworld.com/hurricane/distribution/spatialdistribution.html]

AREA OF DEVELOPMENT

- Develop between latitudes 30° N and 30°S.
- Result of the confluence of the Tropical easterlies at 5°N - 30°N and 5°S to 30° S of the equator.
- Do not develop on the equator and 5°N and 5°S because there is a weak Coriolis force that can deflect the wind.

OTHER NAMES:
Named differently in different regions:

- Hurricane: Golf of Mexico
- Typhoon: Japan and eastern China
- Tropical cyclones: Africa and Australia

SOURCE OF ENERGY:

- Latent heat is released as warm, moist tropical air condenses.

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CONDITIONS NECESSARY AND REASONS FOR DEVELOPMENT

- 5° N and S of equator - Weak Coriolis force at equator.
- Ocean must be warmer than 26.5 °C – Warm water has a high evaporation rate to feed the LP system.
- Develop only over the tropical oceans – there is less friction over a smooth surface.
- Hot moist air - creates unstable air that continue to rise.
- Unstable air results in condensation - condensation release latent heat into the atmosphere which provides more energy.
- Surface air convergence - Air is forced to rise when it converges at a low-pressure system.
- Upper air divergence - More moist air is drawn into the system at the surface as the air diverge in the upper air.
- Intense low-pressure cell enhanced by the tropical jet stream in the upper air – because of stronger surface convergence, convection and upper air divergence.
- Needs Coriolis forced to cause spiraling winds - deflection of air results in clockwise circulation in Southern Hemisphere.

CHARACTERISTICS OF A TROPICAL CYCLONE

- Intense low-pressure system, below 1000 hPa.
- Late summers and autumns over warm tropical oceans.
- Clockwise movement of air in Tropical Cyclone in the Southern Hemisphere.
- Steep pressure gradient increases the wind speed.
- Winds up to 300km/h.
- Move from west to east within the tropical easterlies.
- Eye develop in the centre of low pressure.
- High Cumulonimbus clouds forms the eye wall.
- Heavy rainfall, hail, storm surges and hurricane winds.
- Receive alphabetic names.
- Affect the east coast of continents.
- Develop only over oceans, dies out over land because of friction and lack of moisture.

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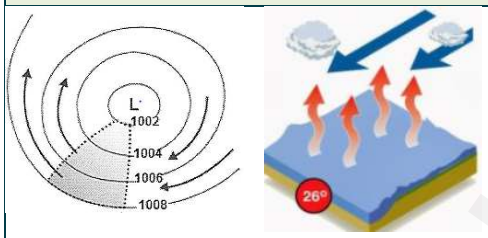
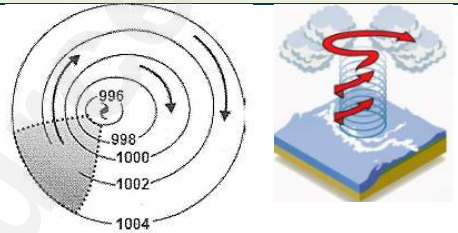
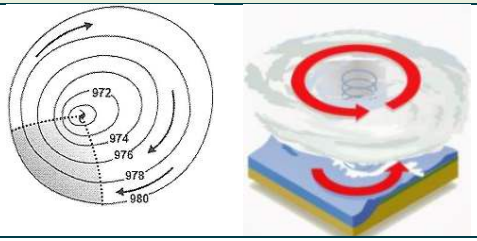
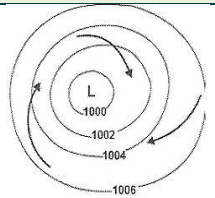
STAGES OF DEVELOPMENT OF TROPICAL CYCLONES

INITIAL STAGE	DEVELOPMENT STAGE	MATURE STAGE	DECAYING STAGE
			
• Convergence of air towards a low pressure (LP). • Creates a vortex. • Air pressure about 1002hPa. • Wind speed up to 60 km/h. [Source: https://www.legacyias.com/low-pressure-area-may-intensify-into-cyclonic-storm/	• Intensity of storm increases as air continue to coverge and rise in LP centre. • Divergence takes place in upper atmosphere. • Air pressure drops below 990hPa. • Wind speed increases to about 120 km/h. • Eye forms in centre of LP. • Huge cumulonumbus clouds forms the eyewall around the eye. • Huge cumulonumbus clouds forms around the eye and swirls to form a vortex.	• Storm reach its maximum intensity. • Pressure drops to about 950 hPa. • Wind speed exceed 180 km/h. • Fully developed eye. • Eye is clear, cloudless due to adiabatic warming of subsiding air. • Vortex well developed. • Up to 600 km in diameter. • Torrential rain, thunder and lighting.	• Air cools down when entering the temperate latitudes. • Cooler air flows into the cyclone increasing the pressure. • When moving inland, supply of moisture is cut of and surface friction slows it down.

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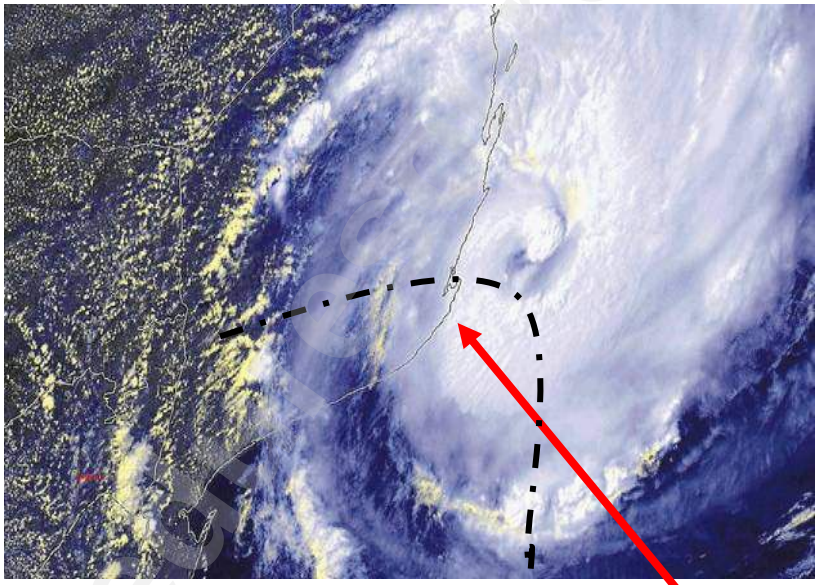
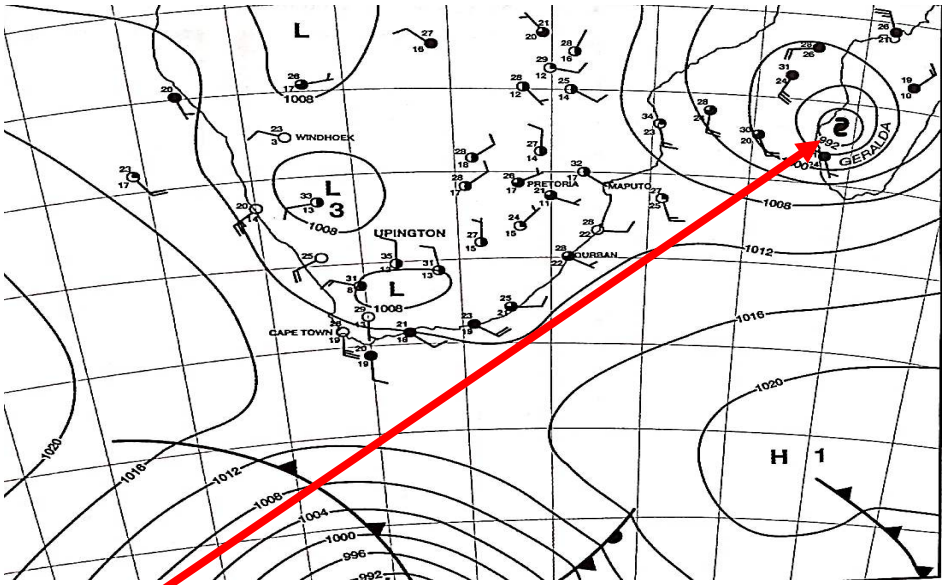
PRESENTATION OF TROPICAL CYCLONES ON SATELLITE IMAGES AND SYNOPTIC WEATHER MAPS

SATELLITE IMAGE	SYNOPTIC WEATHER MAP
 [Source: http://earthobservatory.nasa.gov]	 [Source: https://www.researchgate.net/figure/Surface-synoptic-weather-map]

ACTIVE QUADRANT

- Strongest area of a Tropical Cyclone.
- When winds rotating around the storm center coincide with the winds moving the cyclone system from east to west.
- Forward left-hand quadrant in Southern hemisphere.

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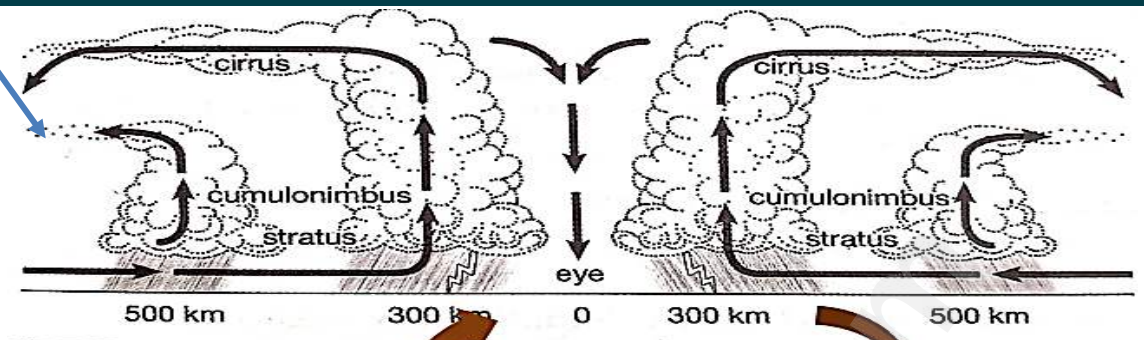
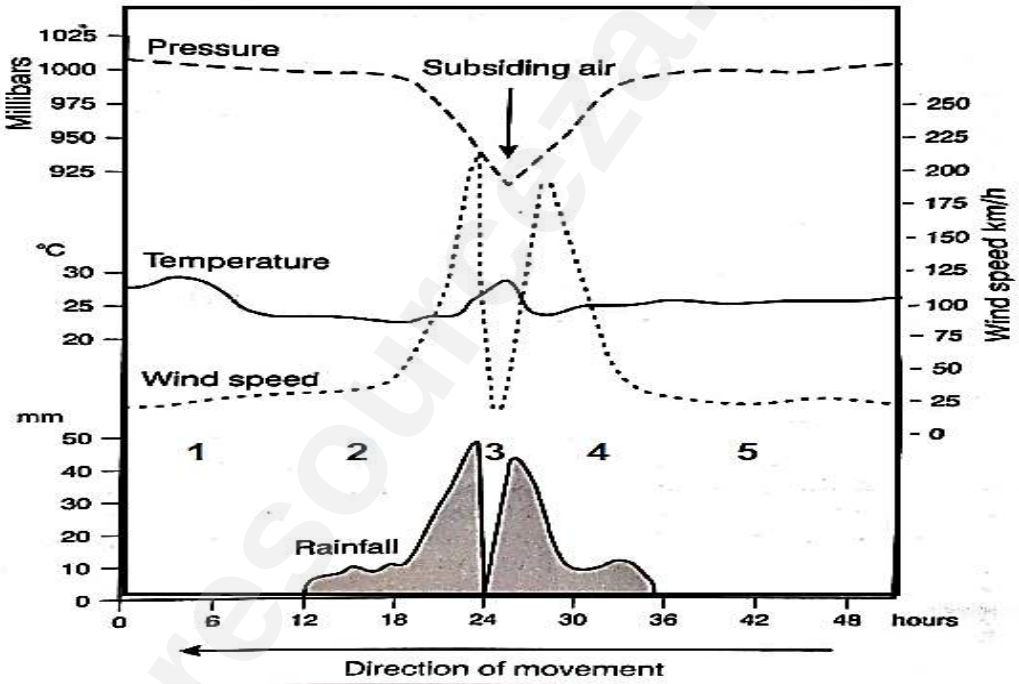
ASSOCIATED WEATHER PATTERNS

CROSS-SECTION



TOP VIEW

WEATHER ELEMENTS



[Source: Adapted from https://wps.prenhall.com/wps/media/objects/616/631756/tropcycl/pages/structurehtml rom Unknown resources]

	1	2	3	4	5
Air pressure	Dropping	Drops	< 950hPa	Rises but still low	Normalises
Temperature	±27°C	Drops due to cloud cover	Rises to ± 28°C due to adiabatic heating	± 27°C	Normilises
Wind speed	Fast	Hurricane strength winds – Strongest in the cyclone	Calm in the eye, no wind	Hurricane strength wind	Slow down and normilises
Rainfall	Light rain	Torrential rain	Clear sky, no rain	Torrential rain	Softer rain that clears up

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IMPACT ON HUMANS, ECONOMY AND ENVIRONMENT

HUMANS	ENVIRONMENT	ECONOMY
• 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 deseases e.g. cholera, typhoid etc. • Major financial strain on families. • Subsistence farmers lose everything. • Swell of waves is dangerous for fisherman/humans.	• 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.	• 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).

STRATEGIES TO MINIMISE THE IMPACT 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.
- Keep livestock in barns to protect them against the wind and rain.
- People should stay indoors to protect themselves against flying debris, wind, and rain.
- Upgrade technology in LEDC countries.
- Good medical care will reduce outbreak of deseases.
- Good emergency services that is well-equipped.
- Local civic/emergency services should be well-prepared to assist.

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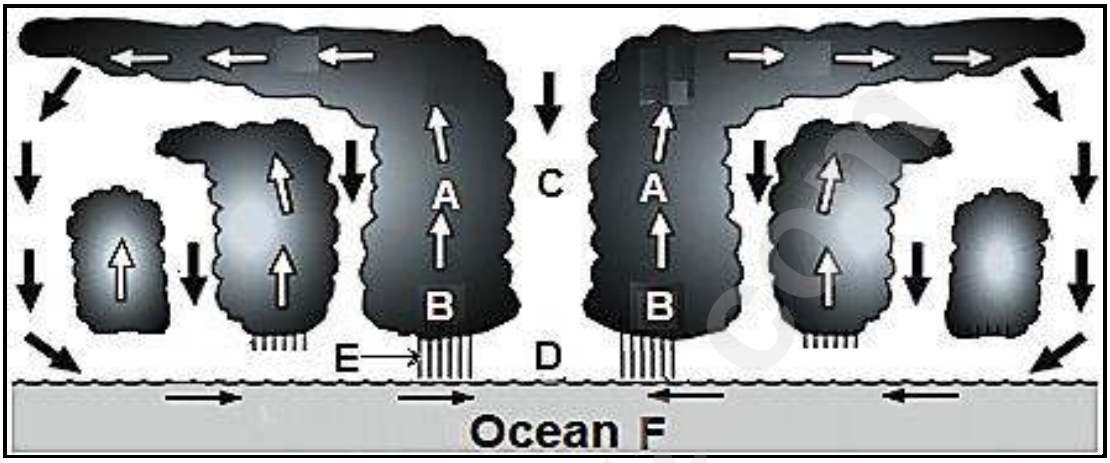
C. ACTIVITY 7.1: TROPICAL CYCLONES

7.1 Refer to FIGURE 7.1 showing a cross-section of a tropical cyclone. Choose the correct word(s) from those given in brackets to make the statements TRUE. Write only the word(s) next to the question numbers (7.1.1 to 7.1.7) in the ANSWER BOOK.



[Source: https://www.tulane.edu/~sanelson/Natural_Disasters/tropical_cyclones.htm

7.1.1 Cloud **A** is a (cumulus/cumulonimbus) cloud.

7.1.2 The updrafts at **B** are caused by (convection/advection) currents.

7.1.3 Area **C** is named the (eye/eye wall).

7.1.4 The atmospheric condition experienced at **C** is (stable/unstable)

7.1.5 **D** indicates an area of (divergence/convergence).

7.1.6 **E** will experience (light rain/thunderstorms).

7.1.7 Ocean **F** is likely (warm/cold). (7 x 1) (7)

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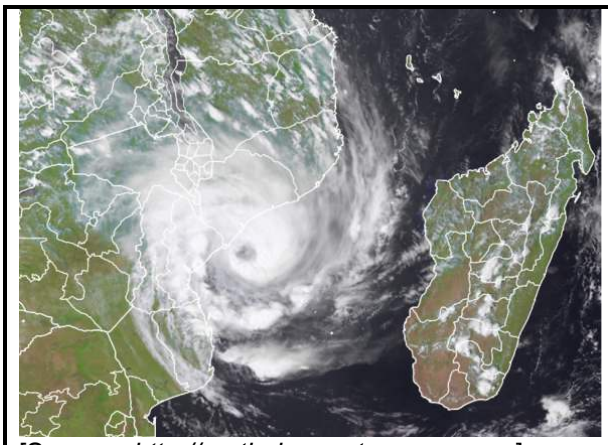
ACTIVITY 7.2: TROPICAL CYCLONES

7.2 Study the Case Study of Tropical Cyclone Eloise which hits Mozambique.



[Source: http://earthobservatory.nasa.gov]

Tropical Cyclone Eloise made landfall early morning on 23 January near Mozambique's city of Beira, causing widespread damage and flooding on a long swathe of coastline and impacting an area still recovering from Cyclone Idai Neighbouring southern African nations are also being hit by torrential rainfall and flooding from Eloise, which weakened to a tropical storm after landfall. Tropical Cyclone Eloise made landfall at Category 1 strength, with winds of 140 km/h and gusts up to 160 km/h,

According to Mozambique's National Institute of Meteorology. Beira received 250 mm of rain in 24 hours, and other areas that were flooded ahead of Eloise's landfall also received additional heavy rains. Eloise impacted Madagascar before crossing the Mozambican Channel, killing at least one person. RSMC La Réunion warned of heavy rains in parts of Zimbabwe, South Africa, Botswana, says WMO regional centre La Réunion. The South African Weather Service issued top-level Red Alerts as floods swept through the northern part of the country, including the famed Kruger National Park.

Eloise poses a serious threat to the coast of Mozambique, and is dangerous cyclone, "according to RSMC La Reunion. "High winds, heavy rainfall and dangerous sea conditions are to be expected. There is a major risk of coastal flooding.

[Source:https://public.wmo.int/en/media/news/tropical-cyclone-eloise-hits-mozambique]

7.2.1 How many tropical cyclones have occurred before tropical cyclone Eloise in this season? (1 x 1) (1)

7.2.2 Give evidence from the satellite photo that Eloise is a tropical cyclone in the Southern Hemisphere. (1 x 2) (2)

7.2.3 In what stage of development is this weather system? (1 x 1) (1)

7.2.4 Give a description of the characteristics of the storm in this stage. (2 x 2) (4)

7.2.5 In a paragraph of approximately EIGHT lines describe the possible impact that Eloise will have on Mozambique, Zimbabwe and South Africa. (4 x 2) (8)

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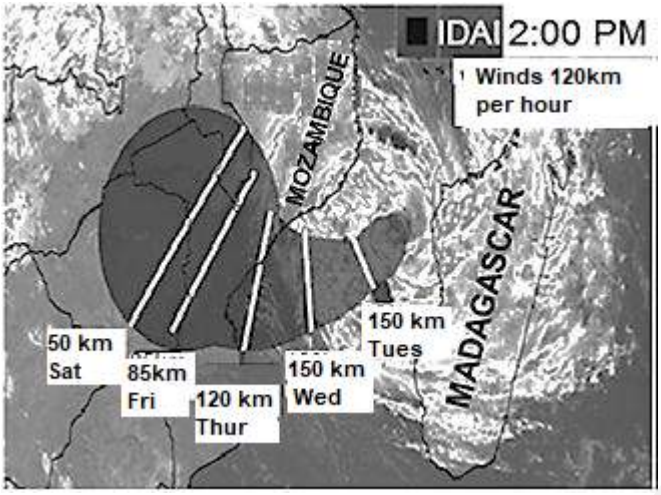
ACTIVITY 7.3: TROPICAL CYCLONES

7.3 FIGURE 7.3 is based on a case study of a tropical cyclone that recently affected Southern Africa.

FIGURE 2.3



[Adapted from turntable.kagiso.10]

Tropical cyclone Idai has quickly strengthened into an intense tropical cyclone and has been fluctuating (changing) in intensity over the past 48 hours. An intense tropical cyclone is equivalent to a category 3 hurricane.
Idai is slowly moving in a westerly direction towards Mozambique with wind speeds exceeding 170 km/h closer to the eye.
It is expected to reach the coastal area near Beira, Mozambique's fourth largest city with 530 000 residents, before midnight on Thursday.

7.3.1 Refer to the article. With what can you compare this intense tropical cyclone? (1 x 1) (1)

7.3.2 Name ONE condition that was necessary for the formation of tropical cyclone Idai. (1 x 1) (1)

7.3.3 Refer to the image and determine the expected wind speed with which tropical cyclone Idai will reach the coast of Mozambique. (1 x 1) (1)

7.3.4 Why will the wind speed decrease as you move further from the eyewall? (1 x 2) (2)

7.3.5 Explain how the dangerous semi-circle of tropical cyclone Idai originated (developed). (1 x 2) (1)

7.3.6 In a paragraph of approximately EIGHT lines, suggest the negative impact that high wind speeds will have on the coastal areas of Mozambique. (4 x 2) (8)

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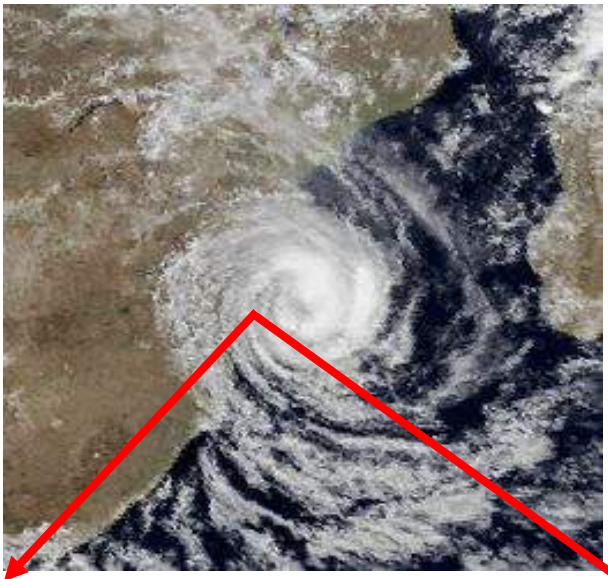
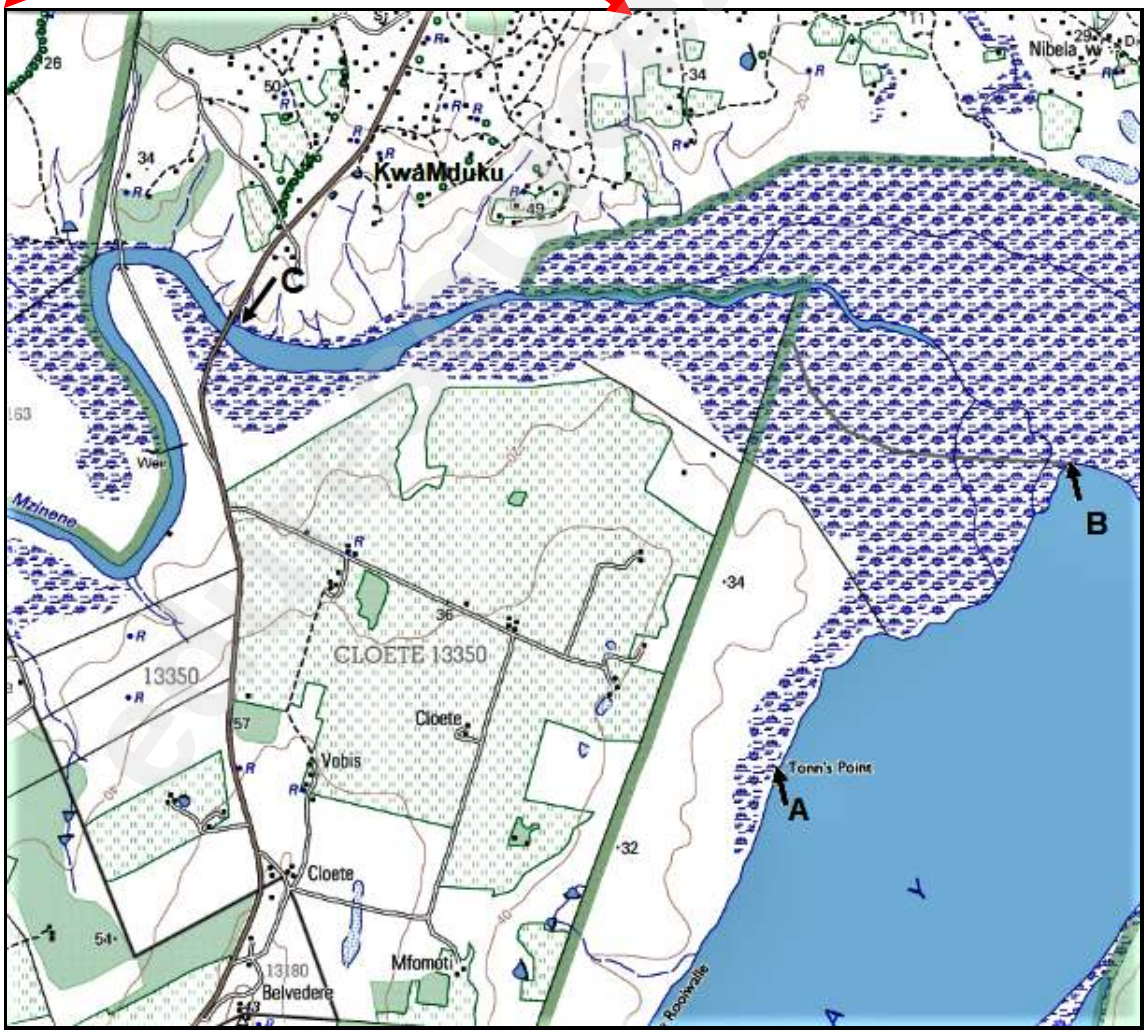
ACTIVITY 7.4: MAP WORK APPLICATION

7.4 Refer to the satellite image of tropical cyclone Idai and topographic map of 2732 CD KULENI Greater St. Lucia) below.



Tropical Cyclone Idai had devastating impact on the St Lucia Estuary

Tropical cyclones will affect South Africa during January and February. Only Tropical Cyclones moving into the Mozambique channel influence South Africa's weather. Shocking images of devastation were recorded on 10 March 2019 when a the bridge over the Mzinene river washed away by the cyclone, which restricted access from of KwaMduku to rescue the residence on the flooded Cloete farm.



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7.4.1 From which direction will tropical Cyclone Idai approach the Greater St. Lucia area? (1 x 1) (1)

7.4.2 Give evidence from the topographic map that the bridge at **C** on the topographic map, was prone to flooding. (2 x 2) (4)

7.4.3 A leisure boat was anchored at Tonn's Point (**A**). Explain what caused it to be blown to point B. (1 x 2) (2)

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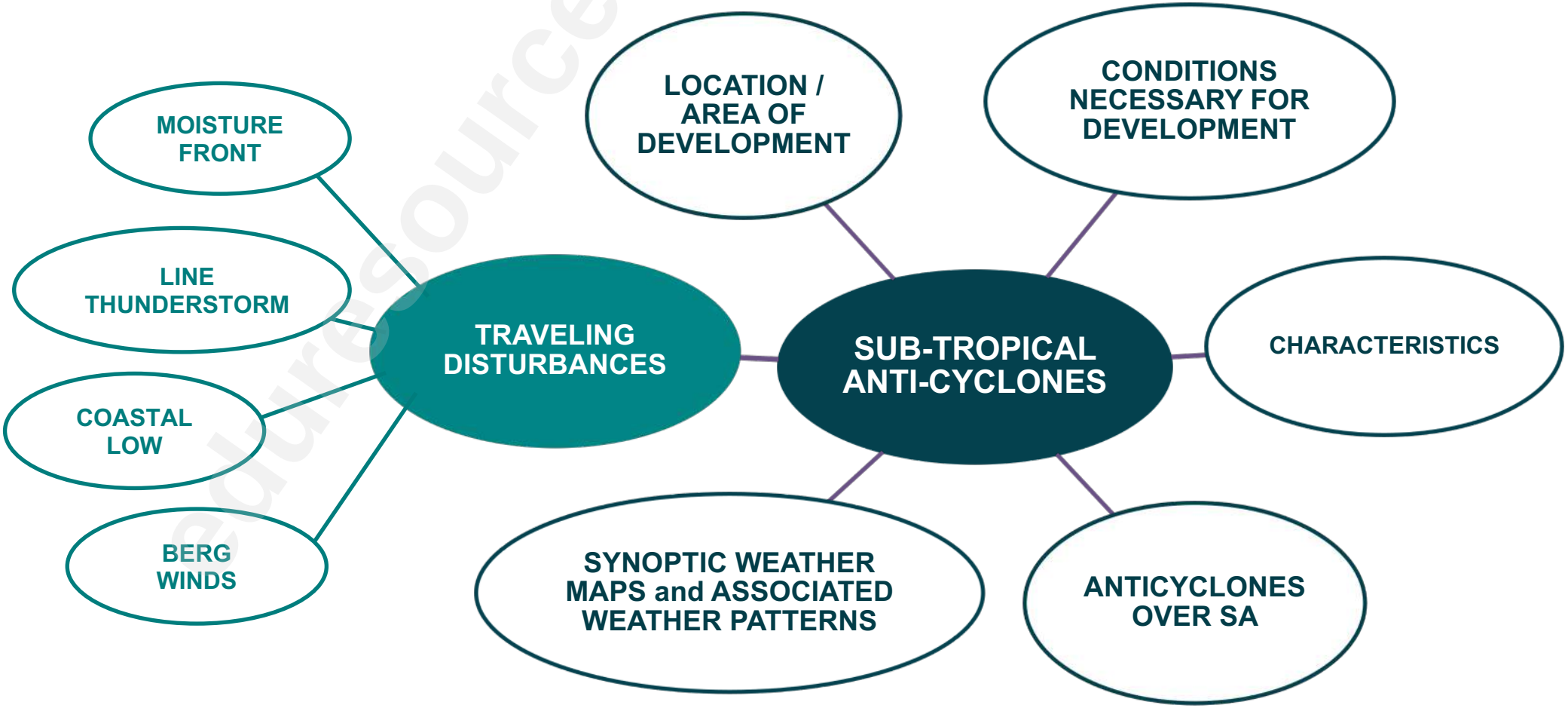
8. SUB-TROPICAL ANTICYCLONES



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A. KEY CONCEPTS: SUBTROPICAL ANTICYCLONES AND ASSOCIATED WEATHER CONDITIONS

Term	Explanation
Adiabatic heating	Heating which occurs when the air is compressed.
Anticyclones	A large high-pressure cell of stable subsiding air.
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 pressure system:	A low-pressure cell which has become completely displaced over the land and moves independently of any air around it.
Inversion layer:	A layer of air where temperature increases with increasing altitude.
Kalahari High:	A large high-pressure cell over South Africa's interior; it is responsible for clear skies and dry conditions in winter.
Line thunderstorm	Summer storms that occur when a trough of low pressure develops over the interior between the thermal low and coastal low.
Moisture front:	A boundary over the interior where warm, moist air blowing from the north-east (Indian Ocean) meets cool, dry air from the south-west (Atlantic Ocean).
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.
South Atlantic High-Pressure:	A large high-pressure cell over the Atlantic Ocean; it sometimes pushes cold fronts inland.
South Indian High Pressure:	A large high-pressure cell over the Indian Ocean; it is responsible for rain in the eastern half of South Africa.
Sub-tropical anticyclones	High-pressure cells of the general circulation centred at about 30° North and South.
Thermal low-pressure:	A thermal low-pressure that develops over the central interior of Southern Africa in the summer.
Trough:	Occurs between two low pressure cells or an extension of a low-pressure cell.
Subsiding air	Is sinking air.

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B. NOTES/SUMMARIES ON SUB-TROPICAL CYCLONES

CLIMATE AND WEATHER REVISION (GRADE 10 AND 11)

1. **Oceans:** South Africa is **surrounded by the ocean** and the weather is influenced by ocean currents.
   - The **warm Mozambique/Agulhas current** over the Indian Ocean. Onshore winds bringing warm air that has high moisture content.
   - The **cold Benguela current** over the Atlantic Ocean flows next to the west coast and onshore winds bring cold/cool air that has low moisture content.

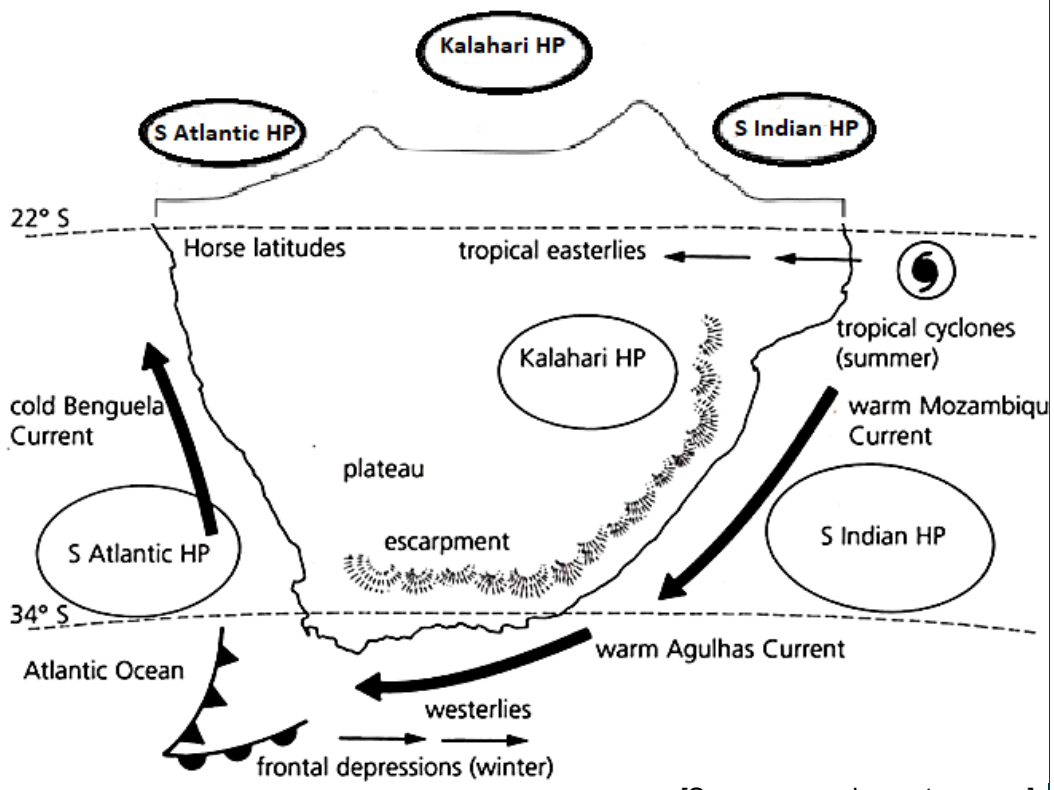
2. **Relief:** The interior part of South Africa is a **high–lying plateau**; temperatures in South Africa are generally lower because the higher the altitude the lower the temperature).

3. South Africa's **latitudinal position** in the sub-tropics results in the weather being affected by the subtropical high-pressure cells, called anticyclones. The anticyclones are:
   - **South Atlantic Anticyclone**
   - **South Indian Anticyclone**
   - **Kalahari Anticyclone**

CROSS SECTION

TOP VIEW

THE 3 MAIN FACTORS THAT INFLUENCE SOUTH AFRICA'S WEATHER



[Source: www.learnxtra.co.za]

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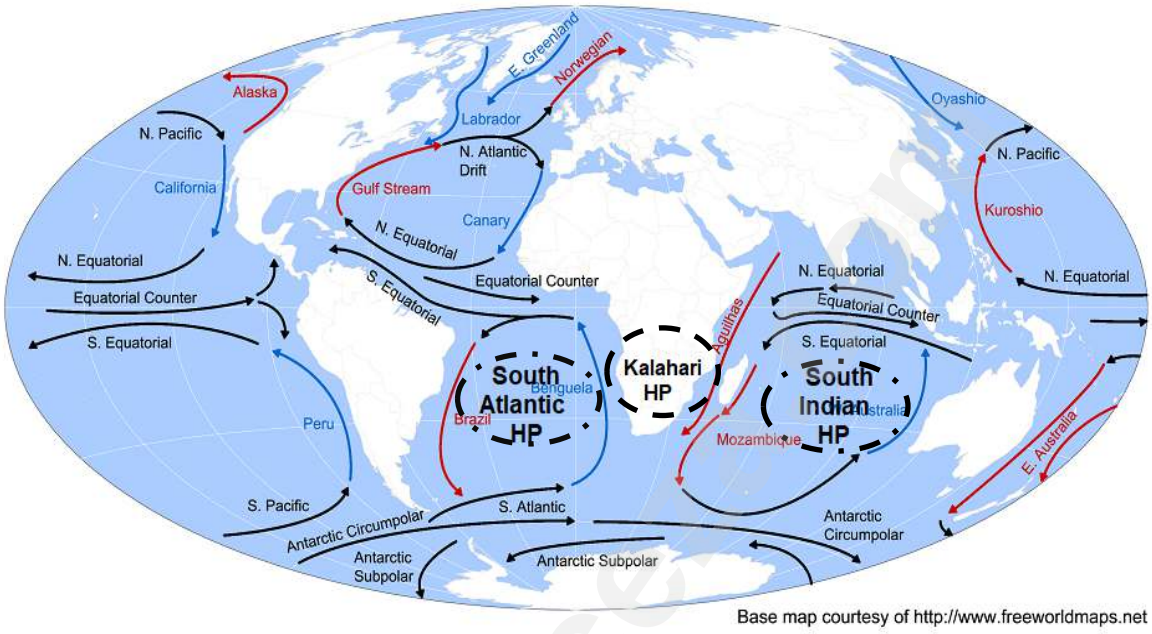
SUB-TROPICAL ANTICYCLONES

CONDITIONS NECESSARY FOR THE DEVELOPMENT OF SUBTROPICAL ANTICYCLONES

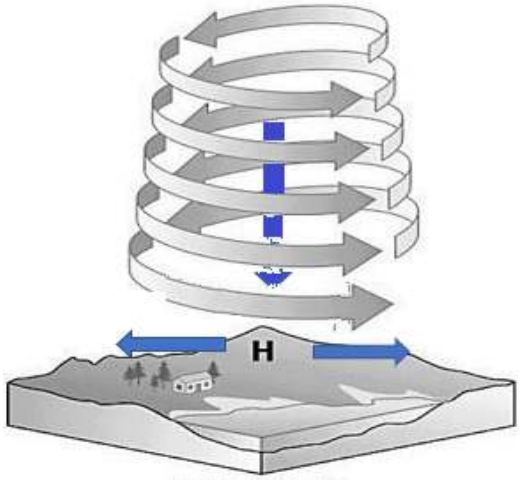
- Descending air from tropical and mid-latitude cells at 30° North and South of the equator.



http://www.ecn.ac.uk/what-we-do/education/tutorials-weather-climate/climate/oceancurrents.png

CHARACTERISTICS OF ANTICYCLONES

- Anticlockwise circulation.
- Air diverges at the centre
- Dry descending air results in stable atmospheric conditions and intensifies high pressure system.
- Clear skies with sunshine.
- Winds blow outwards in an anti-clockwise direction in the southern hemisphere.
- Adiabatic warming of decending air in the anticyclone.



[Source: Unknown]

- Responsible for the semi-arid conditions over South Africa.
- Affect climate of South Africa because of the location at 30° South.
- More prominent in winter over South Africa because of the northward Migration of the ITCZ.

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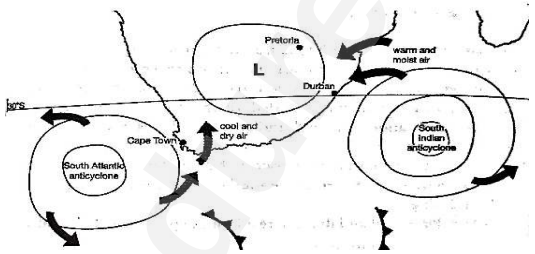
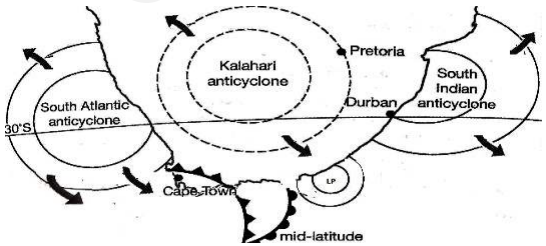
THREE ANTICYCLONES THAT HAVE AN IMPACT ON SOUTH AFRICA'S CLIMATE

SOUTH ATLANTIC ANTICYCLONE

- Location – Namibian coast.
- Semi-permanent and semi-stationary.
- Changes are seasonal, linked to seasonal shift of ITCZ.
- Clear, stable weather.
- Air moves Anticlockwise around system.
- Cool dry air moves into the western and southern coasts.
- May deflect mid-latitude cyclones away from the coast in summer.



- When it ridges in behind cold front weather along front will intensifies.

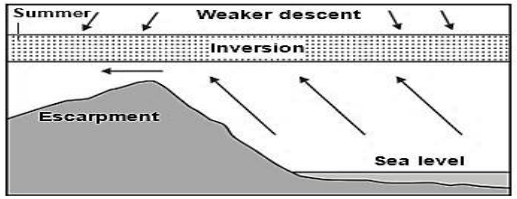


KALAHARI ANTICYCLONE

Location - above the central plateau.

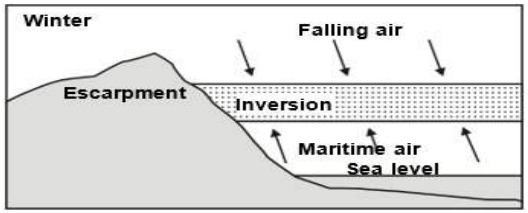
Summer:

- Temperature is warmer above plateau.
- Inversion is formed above the escarpment.
- Moist air from the Indian Ocean can flow into the interior which results in summer rainfall.



Winter:

- Temperature is lower.
- Cool dense air sinks onto the interior.
- Sinking air compress and heat adiabatically which cause lower layers to be warmer than those above.
- Inversion is formed below the escarpment.
- Pressure system rests on escarpment and prevents warm air from the Indian Ocean to reach the interior.



[Source: www.learn.xtra.co.za]

SOUTH INDIAN ANTICYCLONE

- Location - east coast of South Africa.
- Semi-permanent and semi-stationary.
- Air moves Anticlockwise around system.
- When close to SA – moist winds reach the coast.
- Blow over warm ocean.
- Warm, moist onshore winds.
- Cooler land could cause precipitation.

[Sources: https://studylib.net/doc/18585619/session-three--factors-that-influence-weather-in

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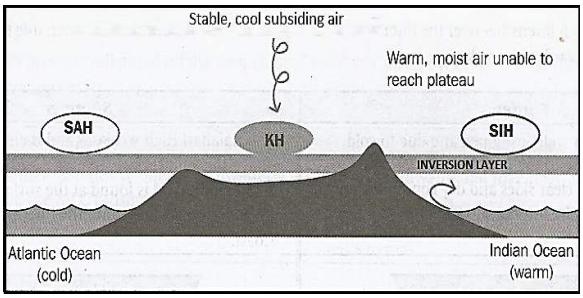
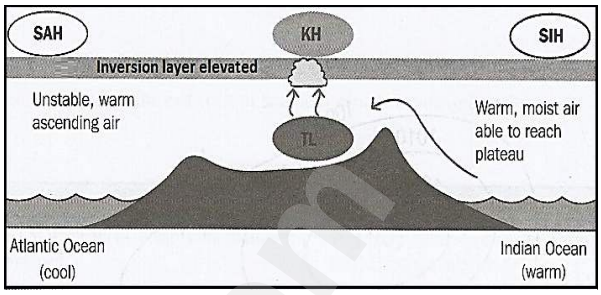
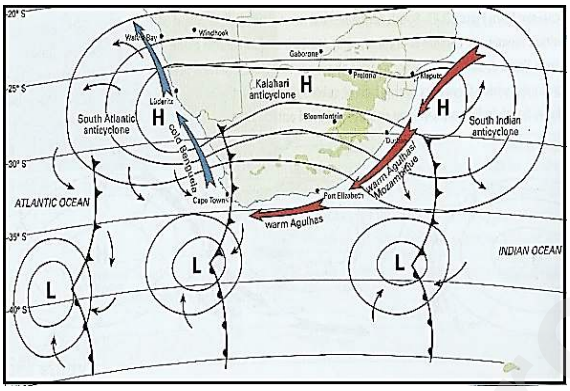
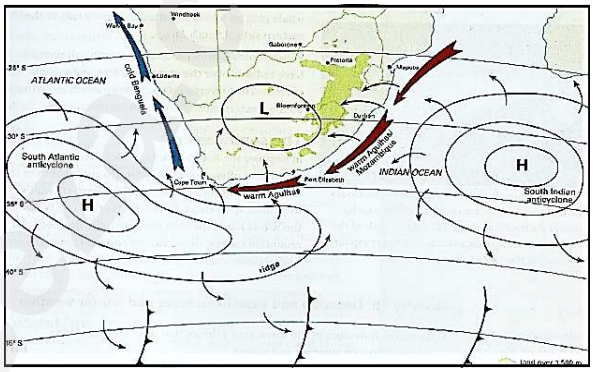
IMAGES, SYNOPTIC WEATHER MAPS AND ASSOCIATED WEATHER PATTERNS

	WINTER CONDITIONS	SUMMER CONDITIONS
CROSS SECTION	 [Source: Ace it, p 54]	
PLAN / TOP VIEW		 [Source: Focus, Geography Grade 12]
ASSOCIATED WEATHER	**Winter:** • Anticyclones are in their northerly position and allow cold fronts to affect the country. • Mid-latitude cyclones move closer to the Southern Coast. • Frontal rainfall over South Western Cape. • Interior is cool, dry and clear because of dominance of Kalahari Anticyclone. • Inversion layer is formed below the escarpment. • Kalahari pressure system rests on escarpment and prevents warm air from the Indian Ocean to reach the interior. • **Berg wind** conditions develop.	**Summer:** • Anticyclones are in their southerly position and prevent the cold fronts from affecting the country. • Kalahari Anticyclone is not present on surface but located in upper air. • Warm air rises and forms thermal LP which are associated with convectional thunderstorms over interior. • Warm, moist air moves in over the escarpment from north-east to bring clouds and rain into interior. • Higher temperatures and humidity over the interior. • **Moisture front and squall line thunderstorms** develop.

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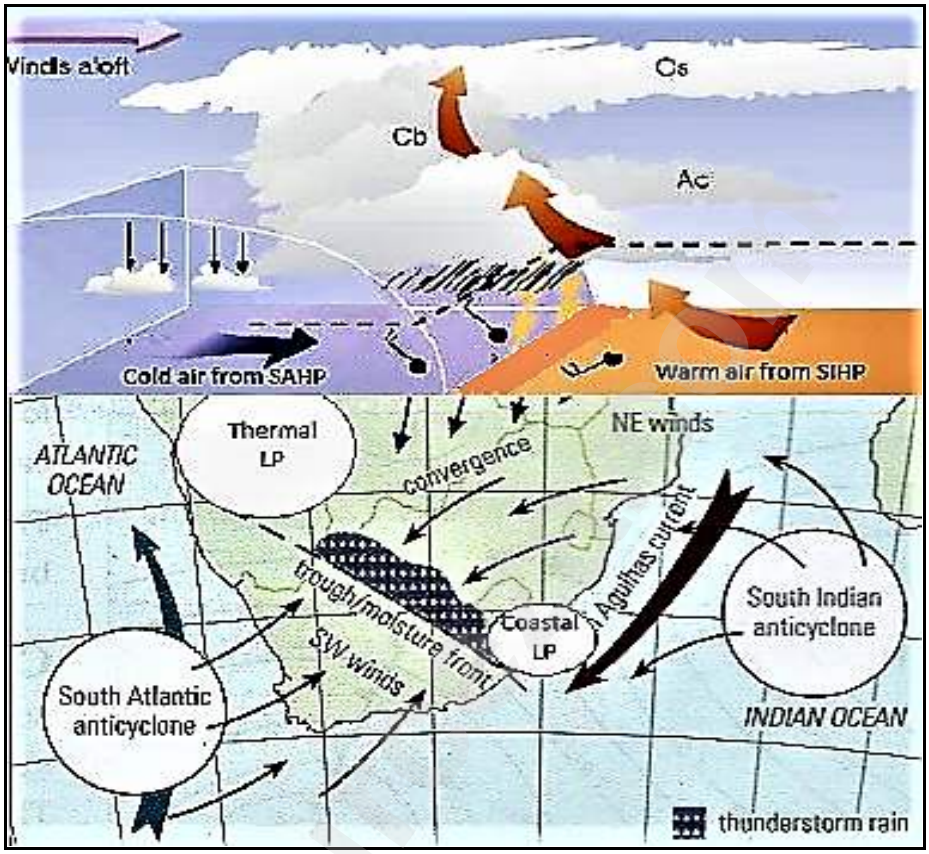
MOISTURE FRONT AND LINE THUNDERSTORMS

CROSS SECTION

TOP VIEW



[Source: Focus, Geography grade 12]

CHARACTERISTICS

- Develop when a thermal/heat low pressure cell and a coastal low is located over South Africa.
- Low-pressure trough forms and feeds moist air into the interior.
- Occurs in summer when the low pressure dominates the interior.
- The moisture front develops where the cool dry air from the South West, meets the warm moist air from the North East.
- The cool air lifts the warm air which cools adiabatically, condenses and forms cumulonimbus clouds.
- Rain falls to the North East of the moisture front.
- No rain falls to the South West of the moisture front.

IMPACT

NEGATIVE:	POSITIVE
• Thunderstorms can cause damage in summer. • Torrential downpour can cause flooding. • Hail, thunder, and lightning can cause damage to property and crops.	• Replenish water in dams • Relief drought in the interior • The heat and the pressure from the lightning turns nitrogen and in the air into natural fertilizer for soil.

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MOISTURE FRONT AND LINE THUNDERSTORMS

CROSS SECTION

TOP VIEW

[Source: https://www.enca.com/south-africa/cut-low-cold-front-brings-rain-and-snow

CHARACTERISTICS

- Line thunderstorms develop along the moisture front.
- When a thermal low-pressure cell - and coastal low-pressure cell is located over South Africa.
- Results in a low-pressure trough that feeds warm moist air to the interior from the northeast.
- It converges with cold, dry air from the southwest.
- Cold air lifts the warm air which cools adiabatically, condenses, and forms tall cumulonimbus clouds.
- Associated with thunderstorms, heavy rain, and possible hail.
- Can occur at night as it is not caused by heating of the atmosphere but convergence of two air masses with cold dry, dense air and warm, moist less dense air.

IMPACT

NEGATIVE:	POSITIVE
• Thunderstorms can cause damage in summer. • Torrential downpour can cause flooding. • Hail, thunder, and lightning can cause damage to property and crops.	• Replenish water in dams • Relief drought in the interior • The heat and the pressure from the lightning turns nitrogen and in the air into natural fertilizer for soil.

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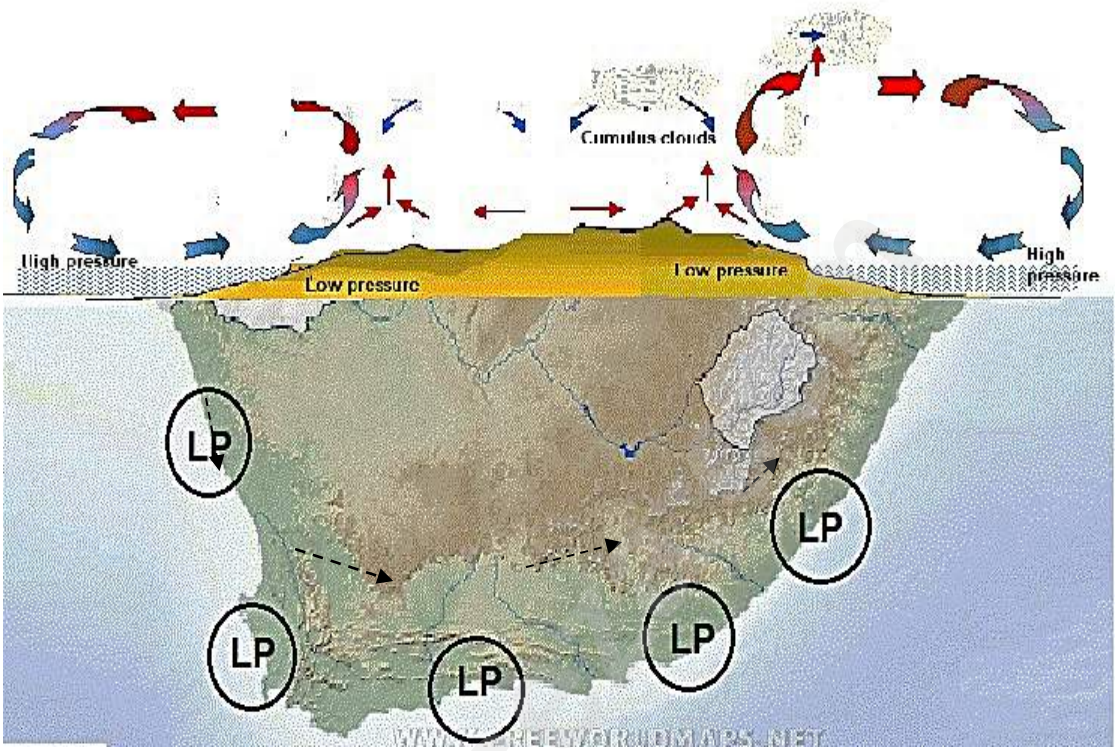
COASTAL LOW-PRESSURE CELLS

DIAGRAM



[Source: Own sketch]

CHARACTERISTICS

- Develop during summer and winter in SA.
- The air moves in a clockwise direction around the cell.
- These low pressure sytems cause completely different weather on either side of the pressure cell.
- On the one side of the pressure cell, air will move from the land to the sea and will cause warmer drier conditions. Also called offshore winds.
- Other side of the pressure cell where the air moves from the sea to the land, moist cloudy conditions will develop that can lead to rain along the coastline areas. Also called onshore winds.
- Low Pressure systems moves from west to east **along the coastline.**

IMPACT

West coast:	**East coast:**
• Onshore winds are cold and dry with limited moisture. • Offshore winds are warm and dry with no moisture.	• Onshore winds are warm with moisture that results in coastal rainfall. • Offshore winds are warm and dry with limited moisture.

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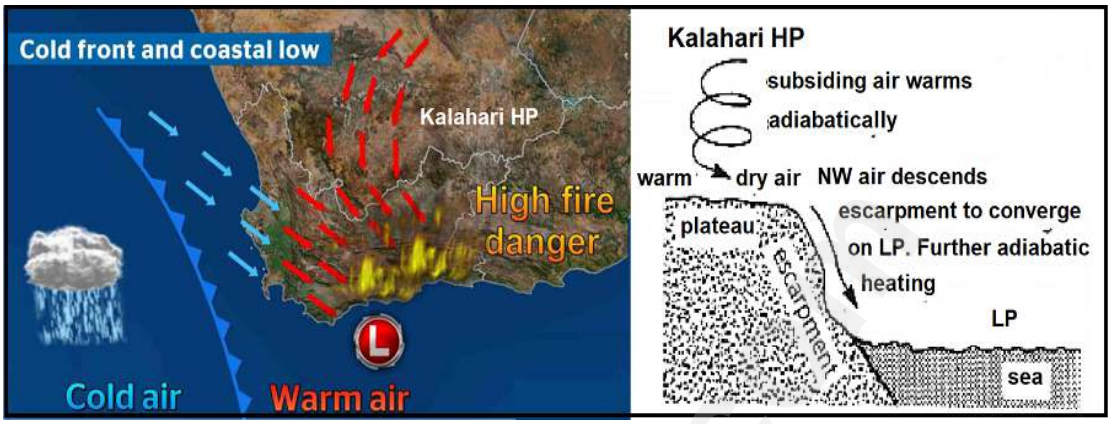
BERG WINDS	
DIAGRAMS	TOP VIEW / CROSS SECTION  [Source: https://learn.mindset.africa/sites/default/files/resourcelib/emshare-show-note-asset/859_fdoc.pdf
CHARACTERISTICS	• Develop during winter. • Gusty, hot, dry winds. • Berg wind conditions occur ahead of the mid latitude cyclone, • Air flows from the Kalahari High Pressure cell to the costal low pressure. • Air subsides from the plateau and down the escarpment (off-shore winds) • Winds 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 encourages veld fires.
IMPACT	• Can encourages the spread of veld fires. • Veld fires impact natural environment, humans and animals. • Farmers may lose houses, equipment and livestock. • Natural bush and grazing may be lost. • Animal habitats may be destroyed. • Dry, warm conditions can cause heat stroke and discomfort. • People and animals can suffer from dehydration.

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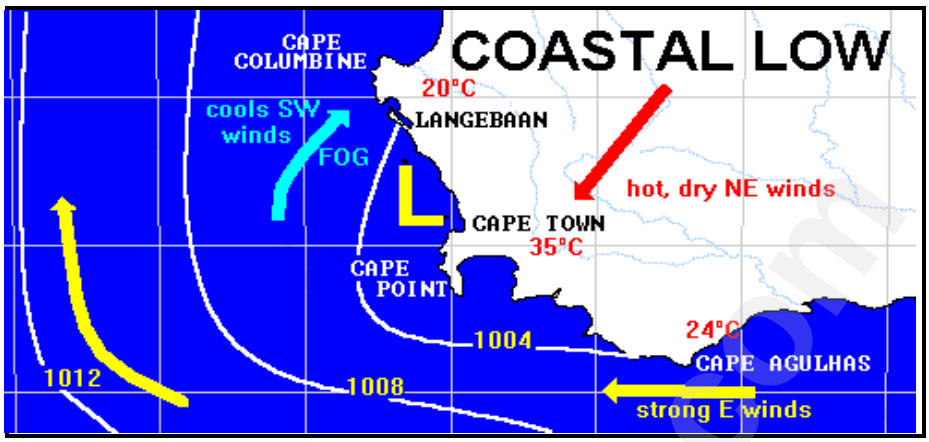
C. ACTIVITY 8.1: SUB-TROPICAL ANTICYCLONES

8.1 FIGURE 8.1 shows a coastal low-pressure cell (L), associated with travelling disturbances.



[Source: http://www.1stweather.com/education.php?wid=77107&prov=WC&metric=true&language=]

8.1.1 Use the isobars to prove that **L** is a low pressure.

8.1.2 Where does low pressure **L** originate?

8.1.3 In which direction does low pressure **L** travel between Langebaan and Cape Town?

8.1.4 What type of precipitation is associated with low pressure cell **L** along the West coast?

8.1.5 State the air temperature associated with the onshore flow of low-pressure cell **L** at Langebaan.

8.1.6 How does air rotate around low pressure cell **L**?

8.1.7 With which travelling disturbance is the hot, dry north easterly wind associated? (7 x 1) (7)

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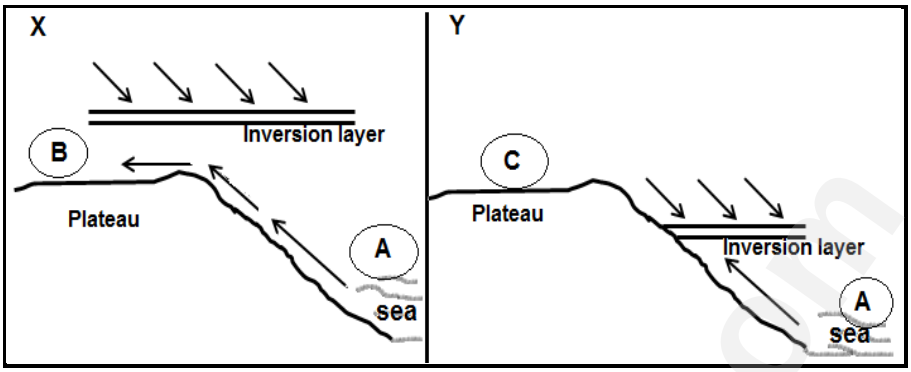
ACTIVITY 8.2: SUB-TROPICAL ANTICYCLONES

8.2 Study FIGURE 8.2, based on a diagram showing the influence of the plateau on the weather and climate of South Africa.



[Source: https://learn.mindset.africa/sites/default/files/resourcelib/emshare-show-note-asset/859_fdoc.pdf

8.2.1 Does sketch **X** or **Y** indicate a summer condition?

8.2.2 Name the pressure cell **A**.

8.2.3 Name the ocean over which pressure cell **A** is located.

8.2.4 Name pressure cell **C**.

8.2.5 Is pressure cell associated with rising or subsiding air?

8.2.6 Will clear and stable conditions occur in sketch **X** or sketch **Y**?

8.2.7 Does a strong or weak subsidence give rise to the position of the inversion layer in sketch **Y**?

8.2.8 Must the inversion layer be above or below the plateau for rain to occur over the interior? (8 x 1) (8)

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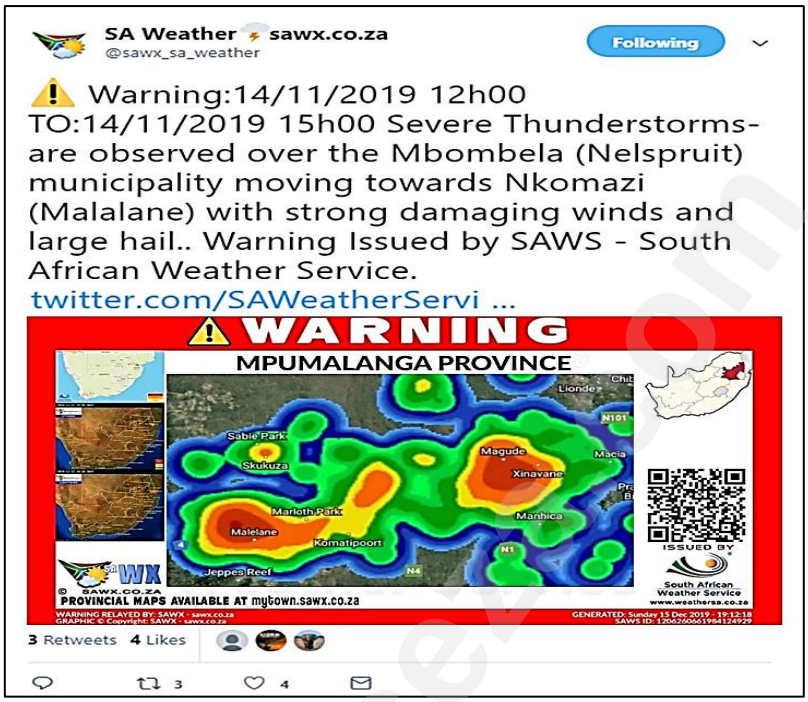
ACTIVITY 8.3: SUB-TROPICAL ANTICYCLONES

8.3 Study FIGURE 8.3, a tweet from SA Weather warning of severe thunderstorms in the Malalane region.



[Source:IEB; 2020]

8.3.1 Name the main weather system responsible for the development of line thunderstorms over South Africa. (1 x 1)) (1)

8.3.2 Name ONE other hazard not mentioned in the tweet. (1 x 1) (1)

8.3.3 Using a diagram, explain how line thunderstorms develop over the interior of South Africa. (5 x 1) (5)

8.3.4 Why are line thunderstorms generally associated with summer? (1 x 2) (2)

8.3.5 Explain why there is a thicker band of clouds to the east of the moisture front (line thunderstorms). (1 x 2) (2)

8.3.6 Explain why the weather conditions associated with line thunderstorms are more severe than isolated (normal) thunderstorms. (2 x 2) (4)

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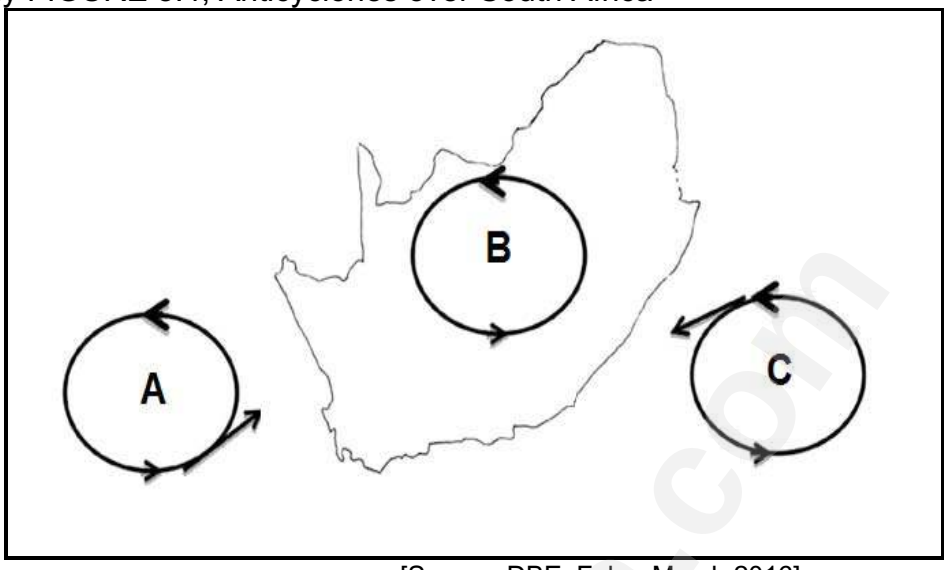
ACTIVITY 8.4: SUB-TROPICAL ANTICYCLONES

8.4 Study FIGURE 8.4, Anticyclones over South Africa



[Source: DBE; Feb – March 2016]

8.4.1 Name anticyclones A, B, and C. (3 x 1) (3)

8.4.2 Anticyclones are associated with stable weather conditions over the interior of South Africa, particularly during winter. Draw a labelled sketch to illustrate the influence of the interior anticyclone on South Africa's weather. (4 x 1) (4)

8.4.3 In a paragraph of approximately EIGHT lines, explain the influence of the intertropical convergence zone (ITCZ) on the changing position of the three anticyclones, relative to South Africa. (4 x 2) (8)

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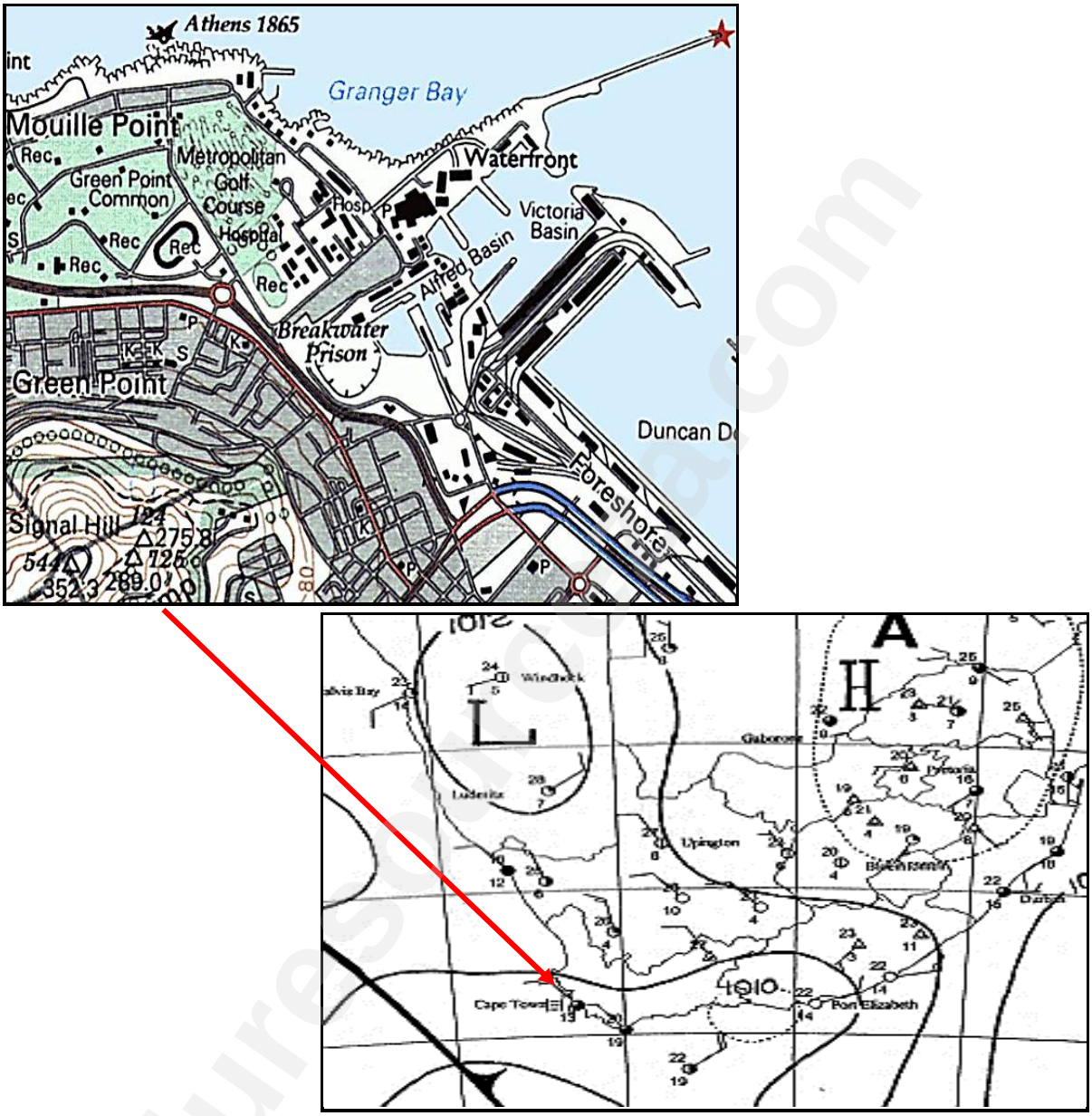
ACTIVITY 8.5: MAP WORK APPLICATION

8.5 Study the extract of the 3318 CD CAPE TOWN topographic map and the synoptic weather map showing a coastal low



[Source: Madmapper.com]

8.5.1 In which direction will a coastal low, located north of Cape Town, move? (1 x 1) (1)

8.5.2 Give evidence that a coastal low has not yet moved along Cape Town (1 x 2) (2)

8.5.3 Describe the weather that will be experienced at Green Point after the coastal low has moved along the coast. (2 x 2) (4)

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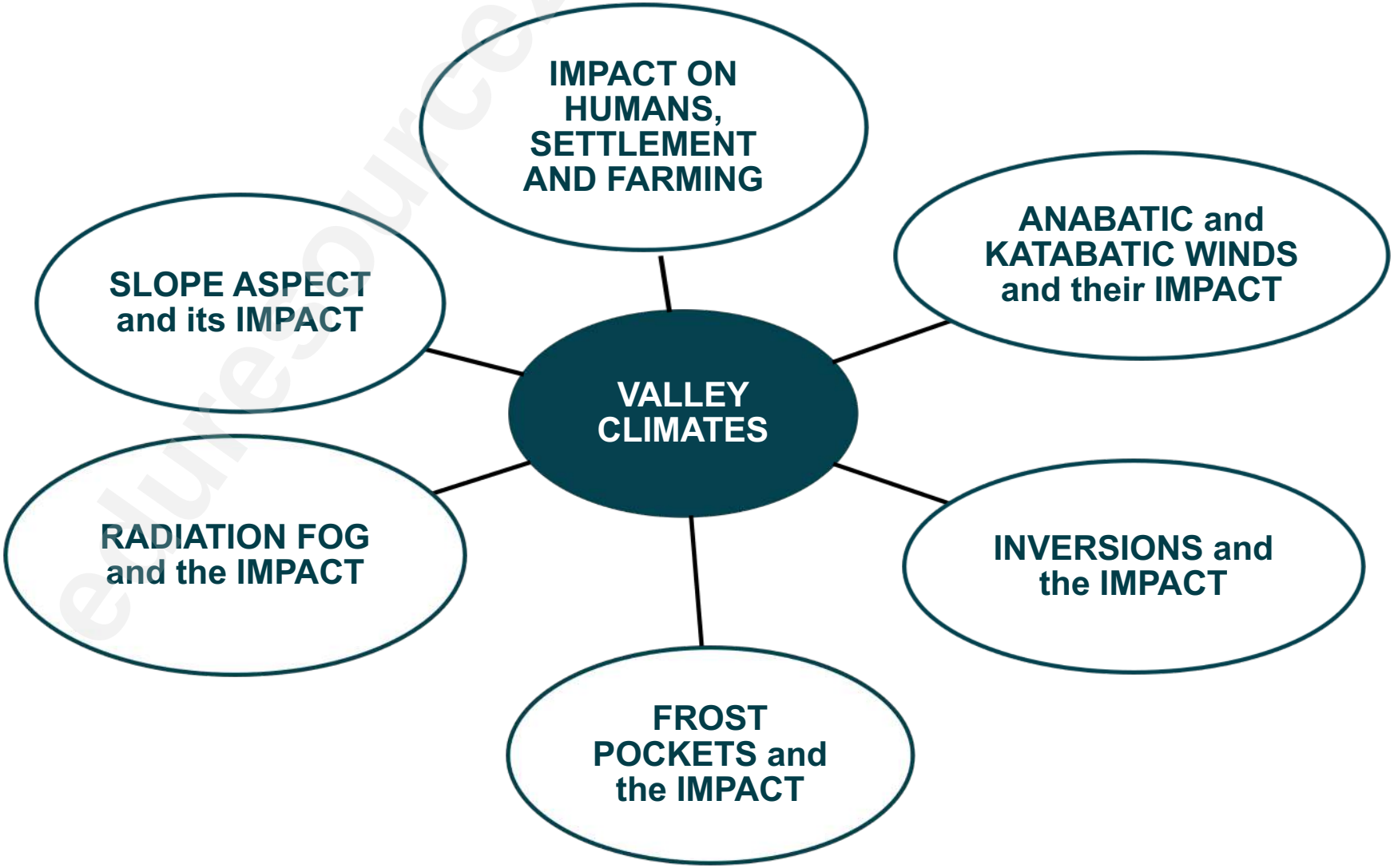
9. VALLEY CLIMATE



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A. KEY CONCEPTS: VALLEY CLIMATE

Term	Explanation
Anabatic wind	A local wind which blows up the length of the valley during the day, because of rising of warm air.
Downslope wind	A local wind which blows down the sides of a valley during the night.
Frost pocket	An area of cold air reaching a dew point temperature below freezing at the bottom of the valley. May occur on clear, calm winter evenings.
Katabatic wind	A local wind which blows down the slope of a valley during the night, because of cold subsiding air.
Microclimate	The climate of a small area that is different to the climate of its surroundings. Three factors contribute to valley microclimate.
Radiation fog	Fog that forms at night under clear, calm conditions. Fog caused by condensation in air that has cooled to dew point temperature as a result of the loss of heat though terrestrial radiation.
Shadow zone	The part of the valley or slope that does not receive any sunlight.
Slope Aspect	Refers to the direction to which a slope faces.
Temperature inversion	An increase of temperature with altitude rather than the usual decrease.
Thermal belt	Warm layer of air midway up a valley with cold air below as a result of inversion of temperature.
Upslope wind	A local wind which blows up the sides of a valley during the day.

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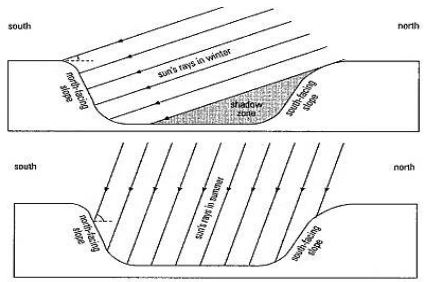
B. NOTES/SUMMARIES ON VALLEY CLIMATE

SLOPE ASPECT

	NORTHERN HEMISPHERE	SOUTHERN HEMISPHERE
CROSS SECTION	[Source: Adapted from https://horticulture.tekura.school.nz/soils/soils-2/ht1032-soils-2-study-plan/soil-temperature/]	

	IN THE SOUTHERN HEMISPHERE		SLOPE ASPECT
ASSOCIATED WEATHER	**North facing slopes:** • North-facing slopes are hot, sunny and dry. • Receive more direct Sun's rays. • Smaller surface area heated thus warmer. • Soils are warmer as they are in the sunny zone. • Farmers have to select a slope which is best suited for certain types of crops. • Warmer part of valley is called the thermal belt. • The effect of aspect is greater in the winter and in places further from the equator.	**South facing slopes**: • South-facing slopes are cool, shady and retain moisture. • Soils are cooler on the south-facing slopes as they are in the shadow zone. • Area in shadow zone on the south facing slope are heated only by reflection.	• Orientation of the slope • Impact change during winter and summer because of ○ migration of pressure systems ○ angle of incomming sun 
IMPACT	• Humans tend to build their houses on north-facing slopes because they are warmer. • Crops that require less moisture and more sunlight will grow on the north facing slopes. • South facing slopes too cold for humans to build settlements. • Trees and shade loving plants such as ferns will grow on the south facing slopes.		

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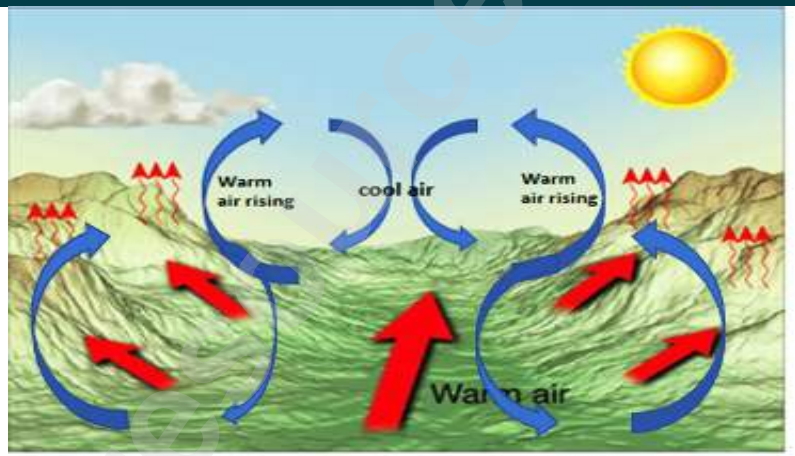
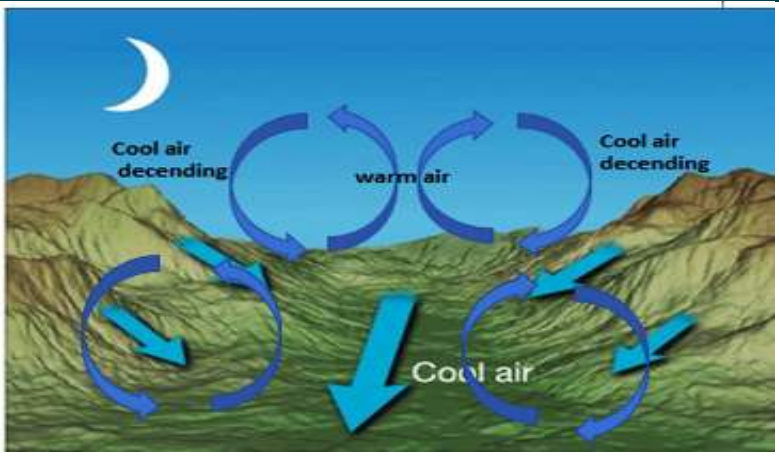
ANABATIC AND KATABATIC WINDS

ANABATIC WINDS AND KATABATIC WINDS		
CROSS SECTION	 [Source: https://www.britannica.com/science/breeze	
CHARACTERISTICS	• The air above the slopes warms, becomes less dense and rises on the slopes of the valley. • This is a warm wind which blows up a steep slope or mountain side, driven by heating of the slope through insolation. • Occurs during the day when the slopes warm due to insolation.	• The air above the slopes becomes cold and dense and descends down on the valley sides/slopes. • This is a wind that carries high density air from a higher elevation down a slope under the force of gravity. • Occurs at night when the slopes cool down due to terrestrial radiation.
IMPACT	• Rising air removes the pollution in the valley to higher altitudes.	• Descending air is cold and captures the pollution on the valley floor which can result in the development of smog and frost.

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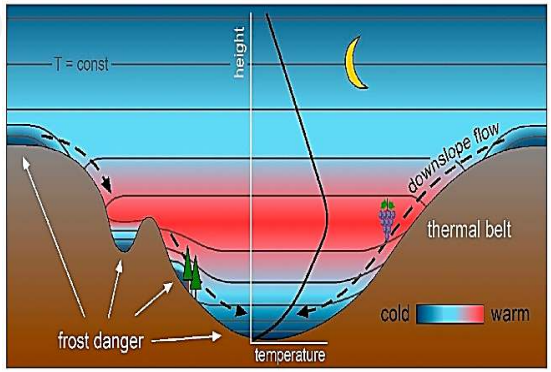
INVERSION, FROST POCKETS AND RADIATION FOG

	INVERSION LAYER	FROST POCKETS	RADIATION FOG
DIAGRAM	[Source: Unknown]	 https://www.mdpi.com/2073-4433/9/10/371	https://www.wmcactionnews5.com/2018/11/20/breakdown-whats-fog-why-does-it-form/
CHARACTERISTICS	• Occurs during calm, cold and clear winter nights. • When cold air drains down the valley slopes and collects at the valley floor. • Warm air is displaced upwards to form an **inversion layer** in the mid-valley. • It is a layer of warm air trapped between two layers of cold air and results in the development of the **thermal belt.** • Can lead to the formation of **acid rain** which corrode buildings and damage crops.	• Low-lying area or valley floor where frosts occur more frequently than in the surrounding high lying areas. • This is normally after a dry, clear and cold night. • Cold air drains down valley slopes • If dew point temperature is below freezing point, it condenses to ice crystals. • Forming **frost pockets** where the cold air collects.	• On cold, clear cloudless nights when rapidly terrestrial radiation occurs. • The ground becomes cool at night. • The air above the ground also cools. • When this air is below due point temperature above 0°C. it causes water vapour to condense around the dust and smoke particles in the atmosphere to create radiation fog. • In the morning the sun heats the surface. • The warm air rises and evaporates. • Combined with pollution in the atmosphere it forms smog.

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IMPACT ON HUMANS AND THE ENVIRONMENT

	HUMANS	ENVIRONMENT
IMPACT	• Frost pocket can cause people to settle mid-slope in the thermal belt. • Smog results in poor visibility and is a health hazard. • Can cause traffic accidents due to poor visibility. • Affects people health e.g. respiratory illnesses.	• Traps pollutants from industries in the area. • Acid rain occurs. • Acid rain damages fauna and flora. • Affect farmers if frost sensitive crops are grown on the valley floor. • Farmers have to plant frost resistant crops. • Damages natural vegetation and crops.

ACTIVITY 9.1: VALLEY CLIMATE

9.1 Give ONE term for each of the following descriptions by choosing a term from the list below. Write only the term next to the question numbers (9.1.1 to 9.1.7) in the ANSWER BOOK, e.g. 9.1.8 climate.

radiation fog; katabatic; temperature inversion; anabatic; smog; thermal belt; frost; aspect

9.1.1 Zone where warm air mass is trapped between colder air masses

9.1.2 A mixture of smoke and fog

9.1.3 The direction in which the slope faces in relation to insolation

9.1.4 Forms when calm conditions and clear skies occur in a valley

9.1.5 Forms on the valley floor when the air temperature is below freezing point

9.1.6 Type of wind that results from air sinking down the valley slope at night

9.1.7 Type of wind that results from air moving up the valley slope during the day

(7 x 1) (7)

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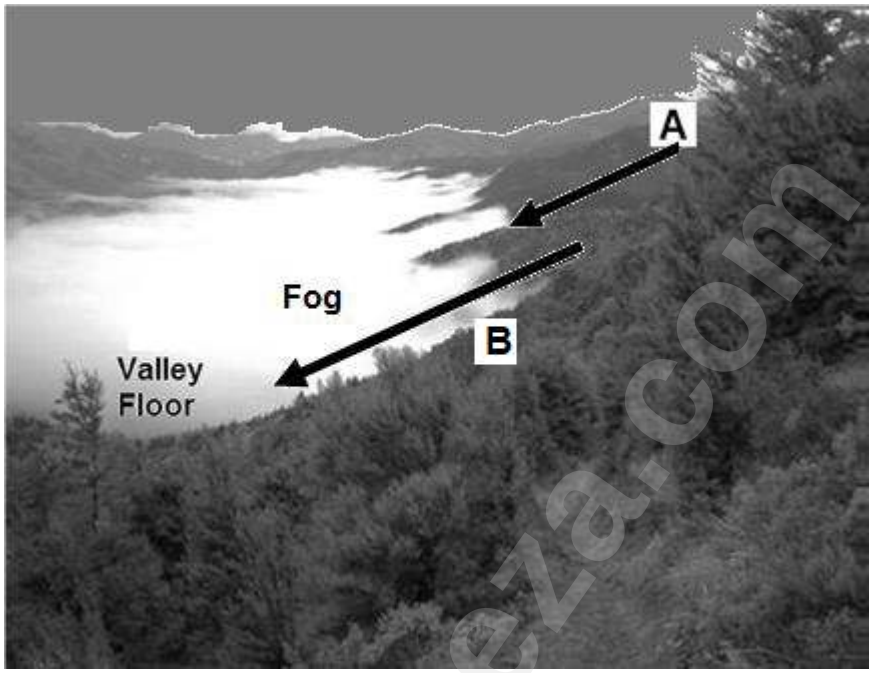
ACTIVITY 9.2: VALLEY CLIMATE

9.2 Study FIGURE 9.2 showing a diagram on valley climates.



[Source: Examiners photo IEB paper of 2011]

9.2.1 Is the slope wind at **A** an anabatic or a katabatic wind? (1 x 1) (1)

9.2.2 **B** above the valley floor is a thermal belt. Give a reason for this statement. (1 x 1) (1)

9.2.3 What is the term used to describe an increase in the temperature as the height increases in the valley? (1 x 1) (1)

9.2.4 Explain why slope wind **A** will be more intense in winter. (2 x 2) (4)

9.2.5 Account for the low temperature that is likely to be experienced on the valley floor during winter and how farmers have to adapt their farming techniques (methods) due to the temperature change on the valley floor. (4 x 2) (8)

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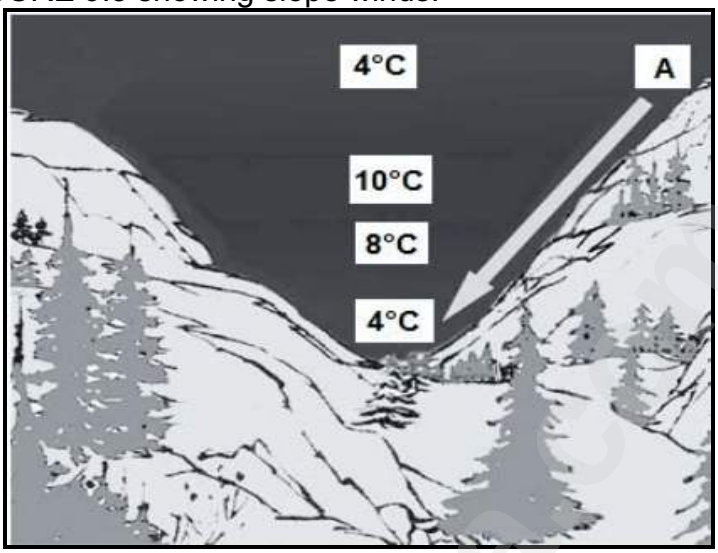
ACTIVITY 9.3: VALLEY CLIMATE

9.3 Study FIGURE 9.3 showing slope winds.



[Source :Adapted from islandnet.com]

9.3.1 Name slope wind **A**. (1 x 1) (1)

9.3.2 State ONE factor that is responsible for the movement of slope wind **A**, as shown in FIGURE 9.3. (1 x 1) (1)

9.3.3 What impact do the uneven slopes have on the air moving downslope? (1 x 2) (2)

9.3.4 Explain why a temperature inversion occurs in a valley at night. (2 x 2) (4)

9.3.5 In a paragraph of approximately EIGHT lines, discuss how slope wind **A** can have both a positive and negative influence on vegetation growth on the valley floor. (4 x 2) (8)

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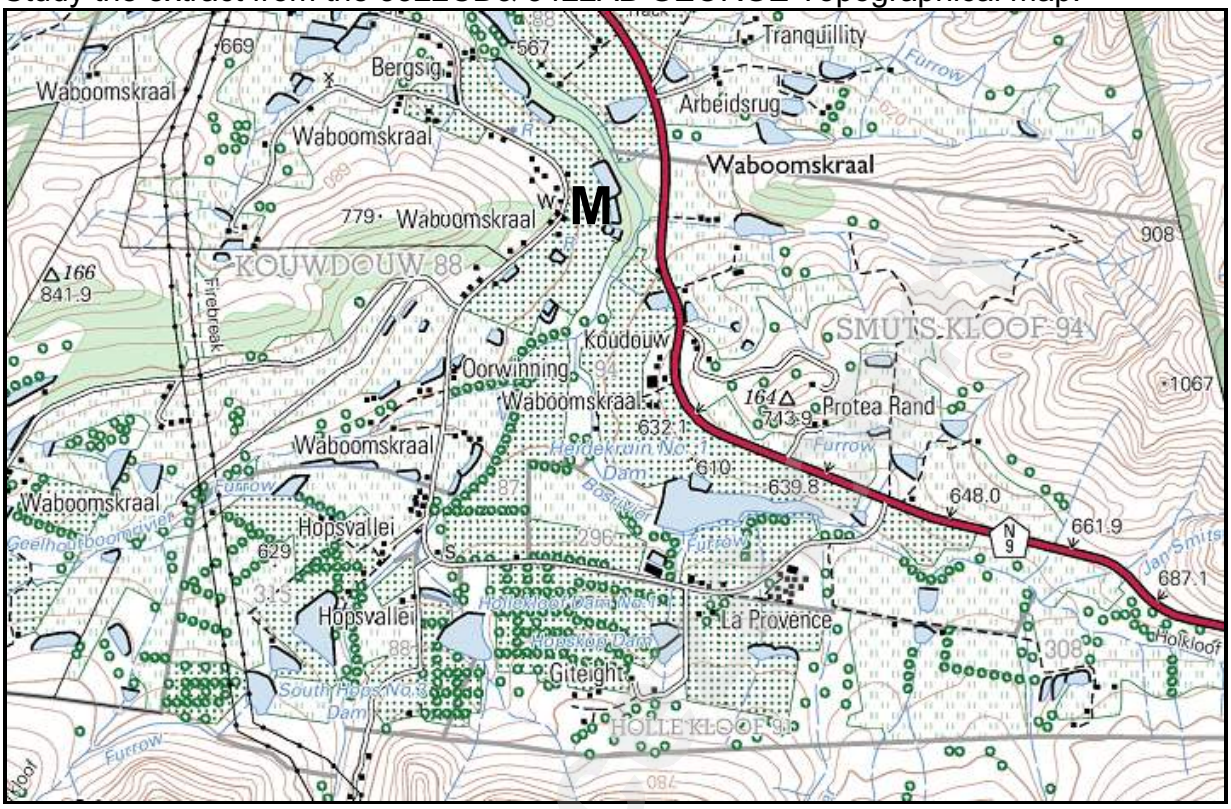
ACTIVITY 9.4: MAP APPLICATION

Study the extract from the 3322CD& 3422AB GEORGE Topographical map.



9.4 The bottom of the valley at area **M** on the topographic map experiences frost in the early hours of the morning during winter.

9.4.1 Name the local/tertiary wind that is responsible for the formation of frost. (1 x 1) (1)

9.4.2 Explain how the wind named in QUESTION 9.4.1 causes frost. (2 x 2) (4)

9.4.3 Give evidence from the topographic map how the farmers adapted their farming products to accommodate the frost in the valley? (1 x 2) (2)

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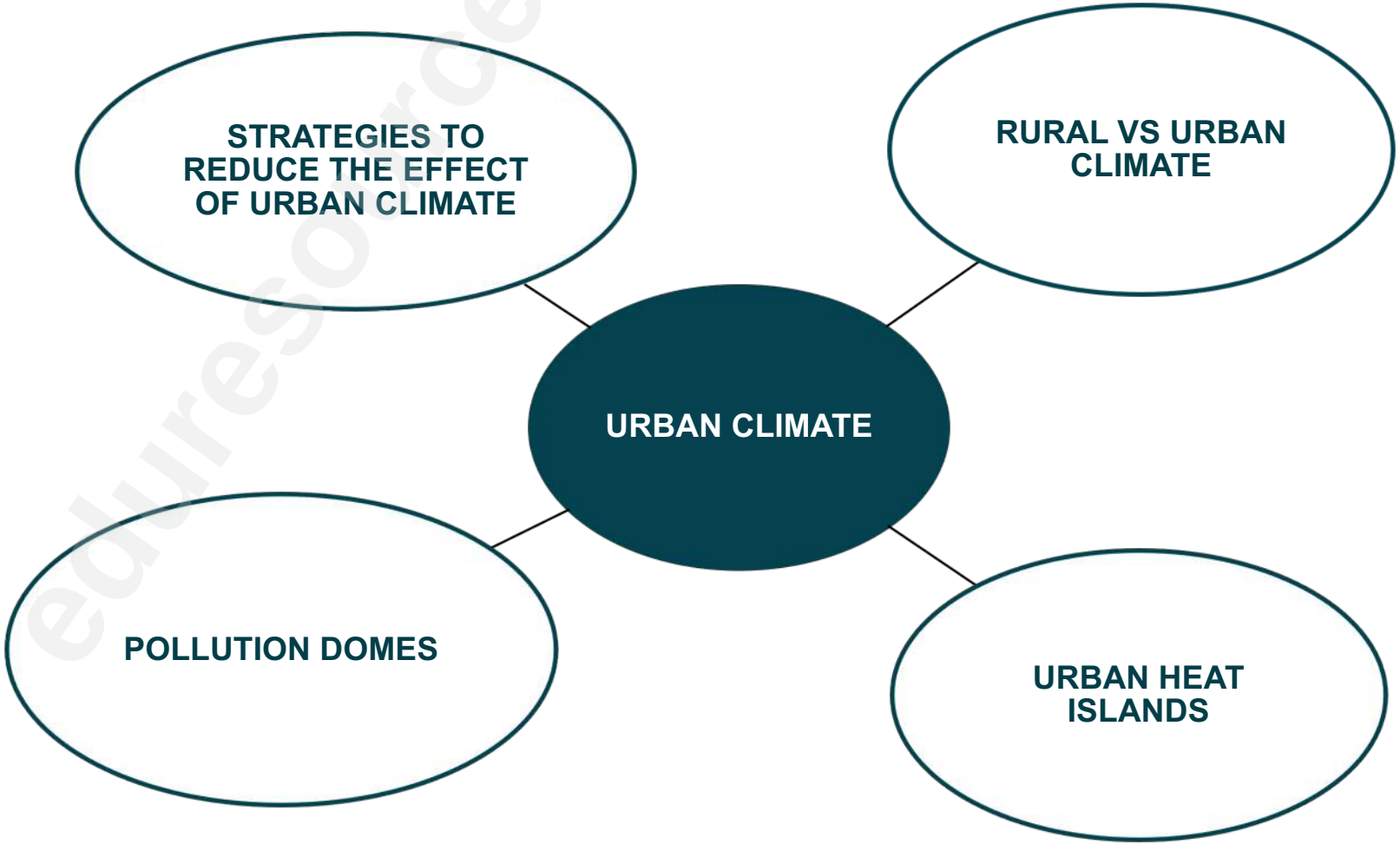
10. URBAN CLIMATE



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A. KEY CONCEPTS

Term	Description
Acid rain	A form of precipitation that is acidic due to water droplets dissolving gaseous pollution molecules.
Albedo	The amount of incoming solar radiation (insolation) that is reflected by the Earth's surface.
Condensation nuclei	Particles of dust, smoke or salt that water vapour sticks to and on which it condenses. Also called hygroscopic nuclei.
Hygroscopic nuclei	Small solid particles in the atmosphere on which water vapour condenses to form tiny water droplets – these water droplets merge to form rain drops which result in cloud formation.
Isotherms	A line on a map connecting points having of equal temperature.
Plume	Smoke, dust, fire, or water is a large quantity of it that rises into the air in a column.
Pollutants	The dome-shaped concentration of polluted air above the centre of a city or industrial area.
Pollution dome	A mass of polluted air temporarily trapped over a city or industrial area.
Smog	A thick, ground level fog caused when water droplets become polluted with chemicals and gasses found in the atmosphere due to pollution. (A mixture of smoke and fog).
Urban climate	Climatic conditions specific to large urban areas.
Urban heat island	The temperature over the city is warmer that the surrounding rural area.

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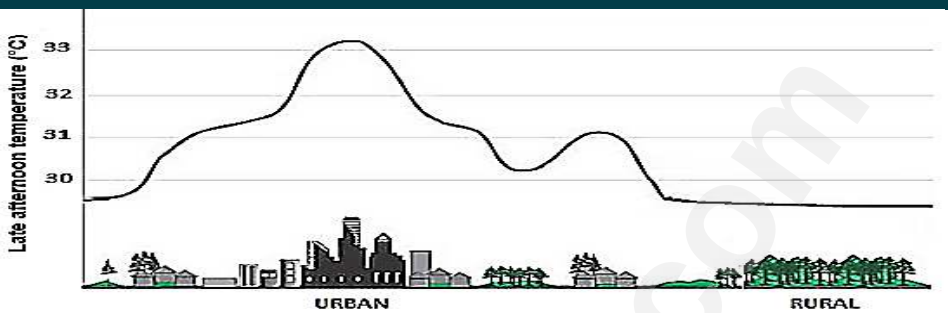
B. NOTES/SUMMARIES ON URBAN CLIMATE

	URBAN CLIMATE	VS	RURAL CLIMATE
CROSS SECTION	 [Source: https://www.metlink.org/fieldwork-resource/urban-heat-island-introduction/		
CLIMATE CONDITIONS	**TEMPERATURE**		
	• Warmer due to lack of vegetation and transpiration. • More artificial heating, air conditioning, vehicle emission. • More artificial surfaces, tar, concrete that absorbs heat. • More dust and pollution prevent heat from escaping.		• Cooler due to fewer artificial surfaces and more vegetation cover.
	POLLUTION		
	• More pollution and dust due to industrial activities, combustion processes and traffic.		• Less pollution and dust particles.
	CLOUD COVER		
	• More clouds form as there are more dust and pollution particles in the atmosphere.		• Fewer clouds because of less hygroscopic nuclei.
	PRECIPITATION		
	• More rain and hail due to more hygroscopic nuclei in the atmosphere and strong updrafts of air. • Warmer temperature causes more evaporations.		• Less rain and hail because lower temperature and less condensation.
	RELATIVE HUMIDITY		
	• Lower evaporation and relative humidity due to lack of vegetation cover and natural resources. • Less surface water to evaporate. • Warmer air can hold more moisture.		• Higher relative humidity due to water retention in soil and vegetation.
	WIND SPEED		
	• Wind speed is less as buildings creates friction and acts as windbreaks. • Greater turbulence because wind is channeled between buildings.		• Wind speed is higher. • Turbulence is less due to open space.

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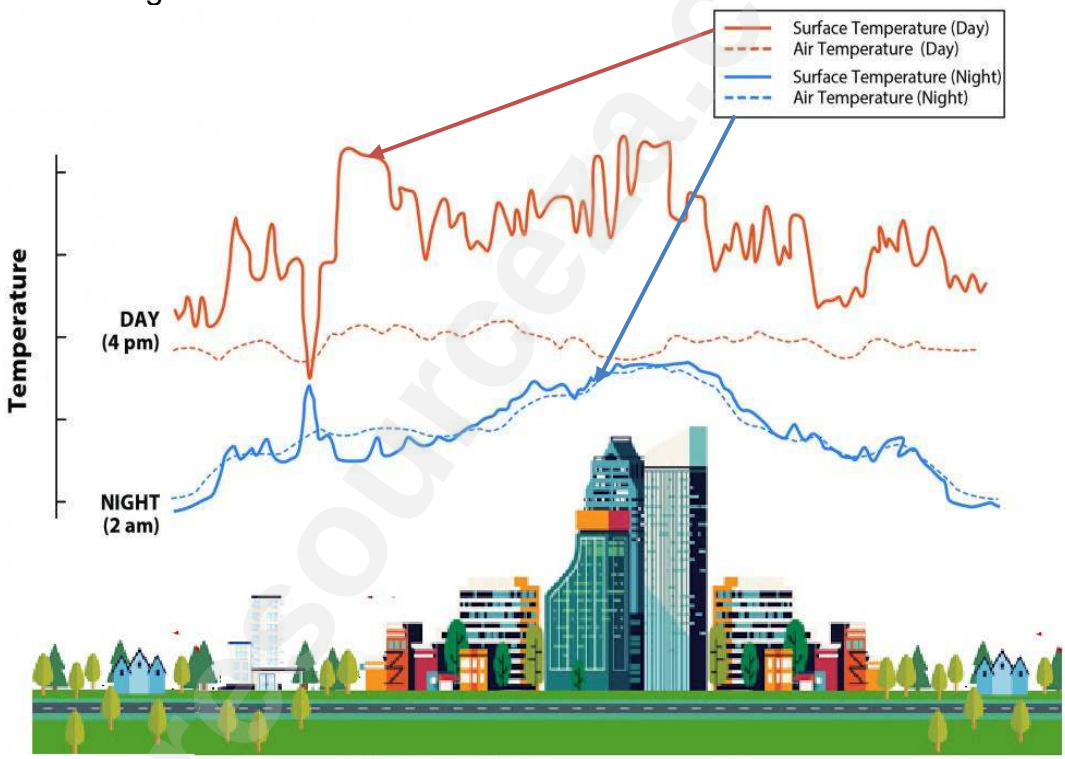
	FOG AND VISIBILITY	
	• More fog and poorer visibility due to more hygroscopic nuclei and condensation nuclei. • Fog is a problem in winter when temperature inversion trap pollutants close to Earth's surface.	• Less fog resulting in better visibility.
	AIR PRESSURE	
	• Lower because of warmer temperature.	• Higher because of cooler temperature.

URBAN HEAT ISLANDS

CROSS SECTION

Urban heat island: The temperature over the city is warmer that the surrounding rural area



[Source: http://thebritishgeographer.weebly.com/urban-climates.html

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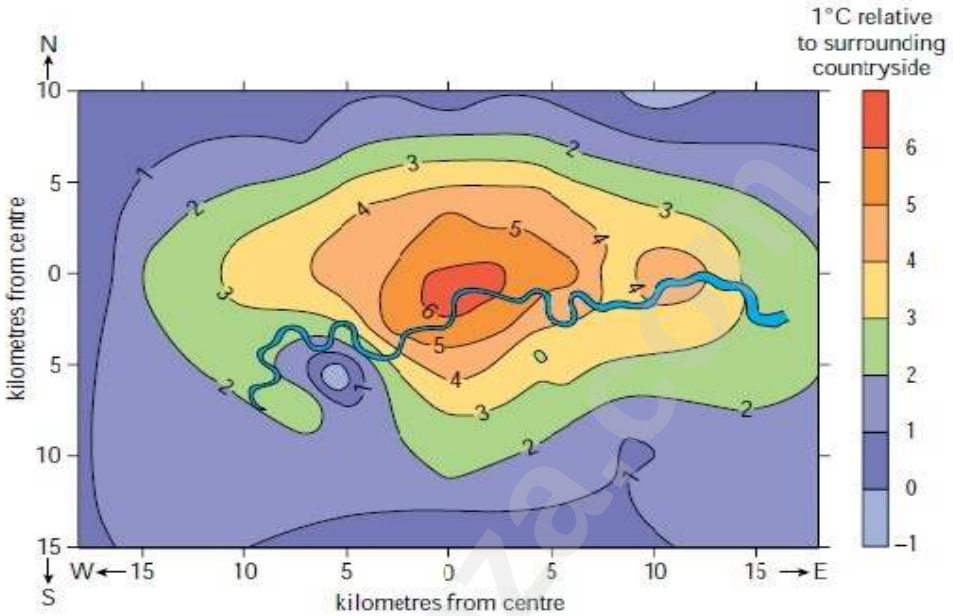
TOP / PLAN VIEW

Isotherms: A line on a map connecting points having of equal temperature.



[Source: https://www.smartcitiesdive.com/ex/sustainablecitiescollective/urban-heat-islands/165241/

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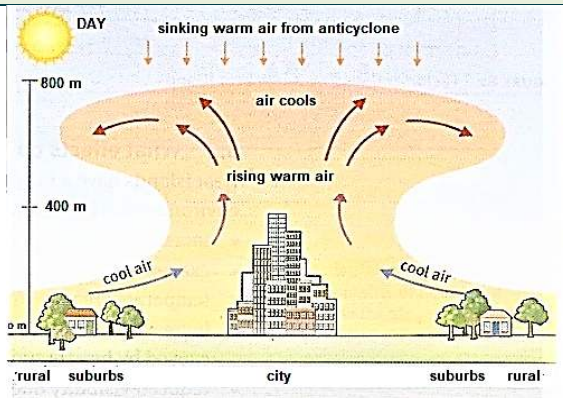
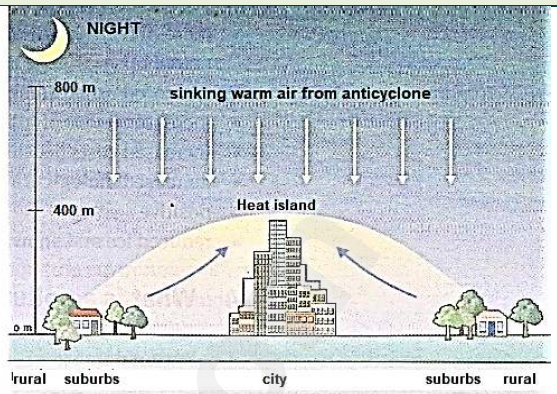
DIFFERENCE BETWEEN DAY AND NIGHT IN URBAN HEAT ISLANDS

	DAY	NIGHT
DIAGRAM		 [Source: Via Afrika, Geography, p97]
CHARACTERISTICS	• Heating causes the air to expand and rise so the heat island grows vertically. • The inversion layer is elevated vertically. • Because of vertical growth the heat is less concentrated. • It may take a mushroom shape. • It conforms to the shape of built-up areas. • Pollution is dispersed over a greater area.	• It is cooler so the air becomes denser and sinks. • Less heat results in decrease in turbulence. • Vertical dimension decreases. • The inversion layer is closer to the surface. • The heat island is more dome shaped and pollutants are more concentrated. • The dome is denser and shallower. • The trapped heat is more concentrated over CBD area.

CAUSES OF DEVELOPMENT OF URBAN HEAT ISLAND AND IMPACT ON THE ENVIRONMENT AND HUMANS

CAUSES	IMPACT	
	ENVIRONMENT	HUMANS

• **Artificial surfaces** in urban areas: glass, concrete, stone, brick, tarmac, iron absorbs more heat.
• **Increased surface area** that can absorb heat – roof and sides of buildings.
• Production of **artificial heat:**
  ○ Combustion of factories produce heat.
  ○ Air-conditioning units' release warm air.
  ○ Emissions by vehicles release heat and pollution.
	• Surfaces absorb heat during the day and radiate heat into the environment at night.
	• Glass radiates heat back into the atmosphere.
	• Increase of urban smog due to higher temperature.
	• Increase in the evaporation rate.
	• Creates a pollution dome.
		• Increase in discomfort.
		• Exacerbated heat stress and deaths during heat waves.
		• Reduced visibility because of smog.
		• Increased costs because of greater water and energy use.

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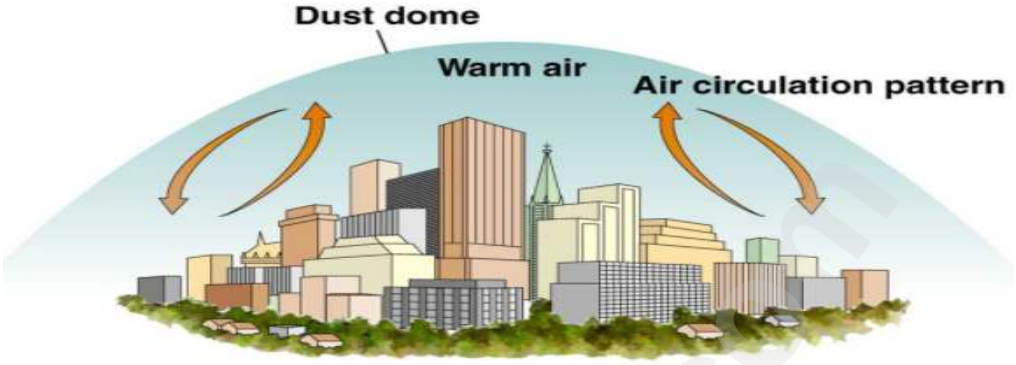
POLLUTION DOMES

CROSS SECTION

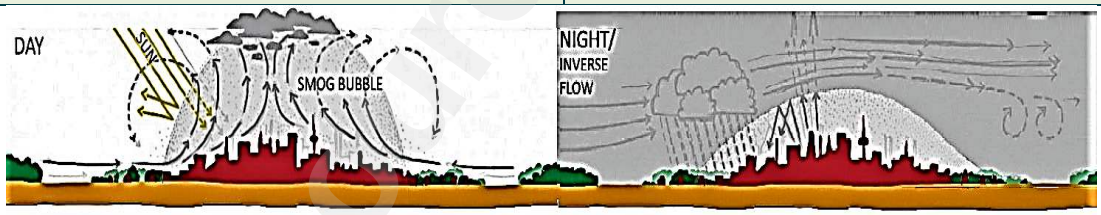
Pollution dome: When dust, soot and chemical emissions are trapped in the warm air of a heat island the dome becomes a pollution dome



[Source: Urban Heat Island Formation, Tozam, Bulut Karaca, 2018]

Pollutants act as **hygroscopic nuclei** and attract water vapour to them, and **fog** develop.
Smog: A thick, ground level fog caused when water droplets become polluted with chemicals and gasses found in the atmosphere due to pollution.

DIFFERENCE BETWEEN THE DAY AND NIGHT IN A POLLUTION DOME

	DAY	NIGHT
DIAGRAM	 [Source:urbangreenbluegrids.com]:	
CHACTERISTICS	• Convection of warm air in the center of the city causes a low-pressure cell to form. • Warm air rises vertically and cool down and diverges in the upper air to spread outward to the rural areas. • Air circulating in the dome spreads the pollution vertically and it is more disperse. • Pollution is carried away by upper air divergence. • Cooler air flows into the low-pressure cell from surrounded rural area.	• Cooler air at night results in pollution dome developing closer to the surface. • This results in the pollution being dense and cannot escape the city. • Pollution is more concentrated because of the inversion layer closer to the earth and pollution cannot escape the dome.

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CAUSES OF DEVELOPMENT OF POLLUTION DOMES AND THE IMPACT ON THE ENVIRONMENT AND HUMANS

CAUSES	EFFECTS	
	ENVIRONMENT	HUMANS
• Emissions by vehicle exhausts – carbon monoxide and nitrogen oxide. • Burning of fossil fuels – carbon dioxide and Sulphur oxide. • The pattern of air circulation and high levels of air pollution in the city.	• Increase of cloud cover and precipitation. • Acid rain develops which kills trees and erodes bricks and stone. • Old paint peeling off buildings. • Contributes to global warming and climate change.	• Smog causes health problems e.g. lung infections, asthmatic attacks. • Smog reduces visibility and accidents. • Lead poisoning may result in petrol fumes.

STRATEGIES TO REDUCE URBAN HEAT ISLANDS AND POLLUTION DOMES
• Make surfaces lighter color to be more reflective and less absorbent. • Greening of cities by planting trees in gardens, onto pavements and in parks. • Trees increase transpiration which decrease air temperature. • Trees absorb carbon dioxide and release oxygen. • Trees reduce energy costs as it has a natural cooling effect. • Plant roof gardens to absorb the heat and pollution. • Invest in energy saving strategies e.g. solar panels and grass roofs. • Develop sustainable public transport. • Implement building restrictions on height and materials used in building projects. • Do not use glass or reflective substances as building materials. • Controlling the amount of pollution released from factories.

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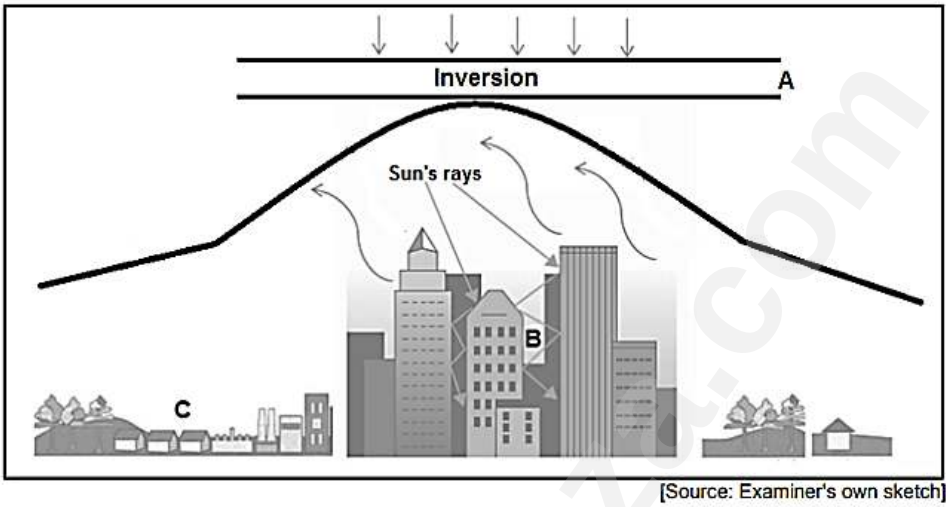
C. ACTIVITY 10.1: URBAN CLIMATE

10.1 Refer to FIGURE 10.1 on city climates. Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number (10.1.1–10.1.8) in the ANSWER BOOK.



[Source: Examiner's own sketch]

10.1.1 The sketch shows a (day/night) situation.

10.1.2 The inversion layer is found at a (higher/lower) altitude during the night.

10.1.3 The inversion layer (increases/decreases) pollution concentration over the city during the night.

10.1.4 The heating of the city at **B** is the result of (multiple reflections of heat/terrestrial radiation).

10.1.5 The channelling of wind between tall buildings (increases/decreases) the wind speed.

10.1.6 Temperature (increases/decreases) from **B** to **C.**

10.1.7 The influence of evapotranspiration on cooling the air will be (less/more) at **B** compared to **C**.

10.1.8 Area **B** is associated with (more/less) cloud coverage compared to area **C**. (8 x 1) (8)

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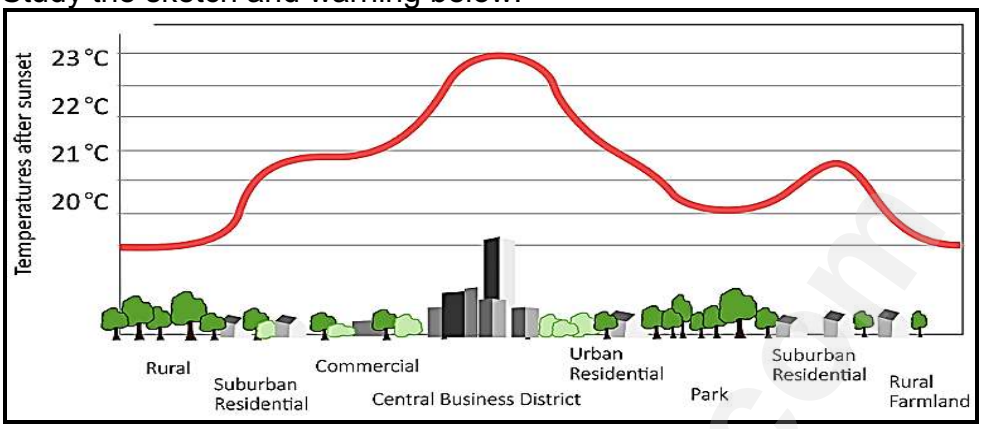
ACTIVITY 10.2: URBAN CLIMATE

10.2 Study the sketch and warning below.



[Source: https://www.metlink.org/fieldwork-resource/urban-heat-island-introduction/]

"Alert – Due to higher temperatures, air quality is poor. Remain indoors and turn on the very aircon that uses the electricity, that's created by the burning of fossil fuel that contributes to both the higher temperatures and poor air quality"
[Source: https://www.metlink.org/fieldwork-resource/urban-heat-island-introduction/]

10.2.1 Define the concept 'heat island'. (1 x 2) (2)

10.2.2 Describe how a heat island is formed. (1 x 2) (2)

10.2.3 Name the part of the urban area **(A)** that records the highest day-time temperatures. (1 x 1) (1)

10.2.4 Describe two ways in which city planners are designing urban centres to reduce the urban heat island effect. (2 x 2) (4)

10.2.5 In paragraph of approximately EIGHT lines discuss how strategies which can be implemented to reduce the heat island effect in urban areas. (4 x 2) (8)

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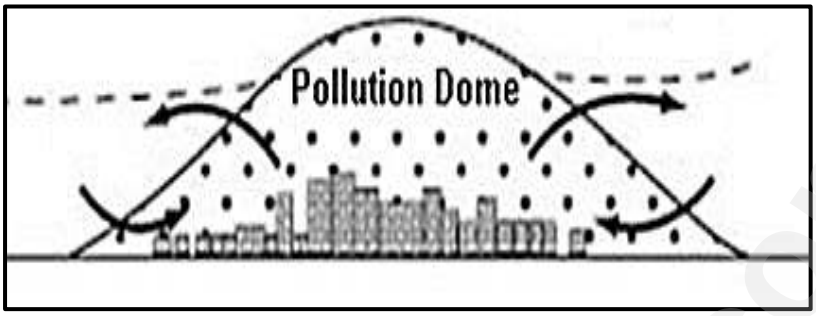
ACTIVITY 10.3: URBAN CLIMATE

10.3 Refer to FIGURE 10.3 showing a pollution dome over a South African city.



[Source: http://www.metlink.org/secondary/key-stage-]

10.3.1 What is a pollution dome? (1 x 2) (2)

10.3.2 Why is a pollution dome associated with an urban area? (1 x 2) (2)

10.3.3 Explain why the pollution dome is more concentrated at night. (2 x 2) (4)

10.3.4 Write a paragraph of approximately EIGHT lines explaining how pollution domes increase the maintenance costs of the built environment for people living in the city. (4 x 2) (8)

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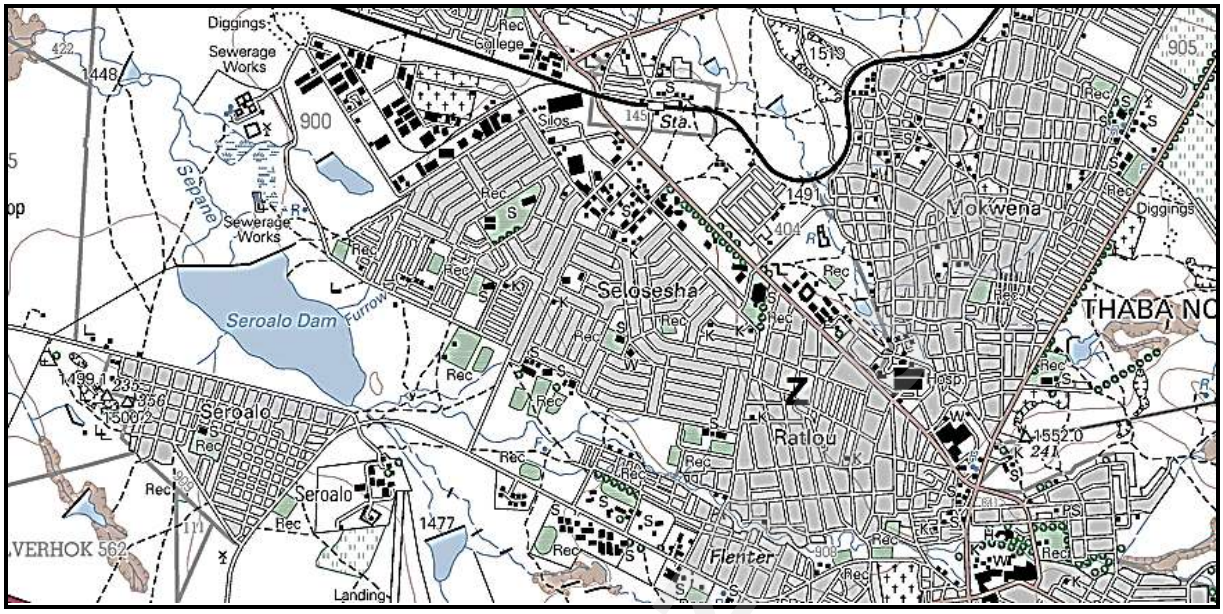
ACTIVITY 10.4: MAP WORK APPLICATION

10.4 **EXTACT FROM THE 2926 BB THANCHU NORTH MAP**



[Source: P2 May /June 2019]

10.4.1 Does the mapped area receive annual rainfall or seasonal rainfall? (1 x 1) (1)

10.4.2 Give ONE reason evident on the topographic map. (1 x 2) (2)

10.4.3 The built-up nature of the suburb, Ratlou, **Z** on the topographic map, has resulted in fairly high temperatures.

(a) Identify TWO factors evident in the mapped area that could reduce the temperature in Ratlou. (2 x 1) (2)

(b) Explain how ONE of these factors mentioned in QUESTION 5.5.1 reduces the temperature in Ratlou. (1 x 2) (2)

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11. POSSIBLE ANSWERS

Revision Activity 5.1 Page 10
5.1 GLOBAL AIR CIRCULATION

5.1.1 Polar High-Pressure Cell (1)

5.1.2 Westerlies (1)

5.1.3 Subtropical High pressure (1)

5.1.4 Polar easterlies (1)

5.1.5 ITCZ/ Intertropical convergence zone (1)

5.1.6 Subpolar High Pressure Cell (1)

5.1.7 Tropical Easterlies (1)

(7 x 1) (7)

Revision Activity 5.2 Page 11
5.2 THE RELATIONSHIP BETWEEN AIR TEMPERATURE, AIR PRESSURE AND WIND

5.2.1 High (1)

5.2.2 Cold (1)

5.2.3 Converge (1)

5.2.4 Diverge (1)

5.2.5 Rise (1)

5.2.6 Low (1)

5.2.7 Warm (1)

(7 x 1) (7)

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6. Mid-Latitude cyclones

Activity 6.1 Page 20

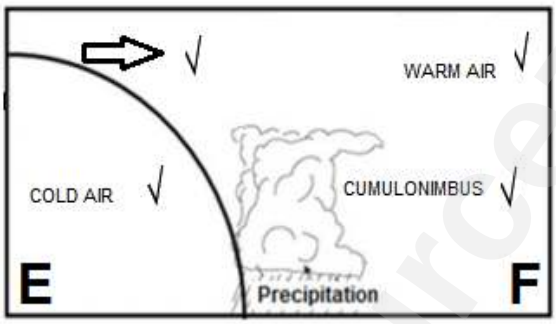
6.1.1 C (1)
6.1.2 C (1)
6.1.3 A (1)
6.1.4 C (1)
6.1.5 A (1)
6.1.6 B (1)
6.1.7 B (1)
6.1.8 B (1) (8 x 1) (8)

Activity 6.2 Page 21

6.2.1 Warm and cold fronts are clearly visible/well defined (1) (1 x 1) (1)

6.2.2 Southern Hemisphere (1) (1 x 1) (1)

6.2.3



(4 x 1) (4)

6.2.4 The warm front approaching location A has a gentle gradient (2)
No large-scale upliftment of warm air at the warm front resulting in gentle rain (2) (2 x 2) (4)

6.2.5 Strong convection before the cold front may results in the development of cumulonimbus clouds and rain (2)
Heavy rainfall with thunderstorms and hail (2)
Lightning associated with expected thunderstorms can be dangerous (2)
Rain may cause flooding of the event (2)
Rain may damage equipment (2)
Insufficient undercover shelter for patrons of the event (2)
Increase in wind speed can cause discomfort (2)
Increase in wind speed can result in hazardous flying debris (2)
Unsecured equipment may be damaged by an increase in wind speed (2)
Drop in temperatures will cause discomfort for patron. (2)
[ANY TWO] (2 x 2) (4)

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Map Work application on Mid-latitude cyclones
Activity 6.3 Page 23

6.3.1 West to east (1) (1 x 1) (1)

6.3.2 North easterly (1) (1 x 1) (1)

6.3.3 **Wind direction** –winds backing from the west to southwest will cause them to approach the harbour against the wind (2)
Wind speed – Very strong to gale force winds will make their access difficult or hinder their entry (2)
Cloud cover – Very thick and towering cumulonimbus clouds will restrict visibility entering the harbour (2) and result in strong convection and stormy water (2)
Precipitation – Heavy rainfall and/or hail will restrict of complicate their entry (2)
[Any TWO, must refer to the weather elements impact]
(2 x 2) (4)

7. Tropical cyclones
Activity 7.1 Page 32

7.1.1 Cumulonimbus (1)

7.1.2 Convection (1)

7.1.3 Eye (1)

7.1.4 Unstable (1)

7.1.5 Convergence (1)

7.1.6 Thunderstorm (1)

7.1.7 Warm (1) (7 x 1) (7)

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Activity 7.2 Page 33

7.2.1 Four (1) (1 x 1) (1)

7.2.2 The map shows the southern African countries (2)
cyclone path is from the eastern side towards the west (2)
on the satellite image air spirals in a clockwise direction (2)
[Any ONE] (1 x 2) (2)

7.2.3 Dissipating stage (2) (1 x 2) (2)

7.2.4 At a disssipating stage, air cools down when entering the temperate latitudes (2)
Cooler air flows into the cyclone increasing the pressure (2)
When moving inland as it can be seen in images, supply of moisture is cut of and surface friction slows it down (2)
[Any TWO] (2 x 2) (4)

7.2.5 Gusty/strong winds (2)
Torrential/heavy rainfall (2)
Coastal flooding (2)
Storm surges (2)
Rough/stormy seas (2)
Damage to infrastructure/property (2)
Outbreak of diseases (2)
Possible loss of life (2)
Destruction of tourism (Kruger National Park) (2)
Drowning of livestock (2)
Prepare for evacuations (2)
[ANY FOUR] (4 x 2) (8)

Activity 7.3 Page 34

7.3.1 A category 3 hurricane (1) (1 x 1) (1)

7.3.2 Sea surface temperatures of 26,5°C and above (1)
Unstable atmospheric conditions (1)
Coriolis force (1)
Calm conditions over the ocean surface (1)
Extensive upper air divergence of winds aloft (1)
Rapid large scale evaporation of moisture over ocean (1)
Release of latent heat (1)
[ANY ONE] (1 x 1) (1)

7.3.3 120 km/h (1) (1 x 1) (1)

7.3.4 Pressure gradient decreases when you move away from the eye (2)
(1 x 2) (2)

7.3.5 Circulation and forward movement in the same direction (2)

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Intense winds in the cyclone combines with the force of the entire cyclone moving forward/westwards into the left hand quadrant (2) (2)
[ANY ONE] (1 x 2)

7.3.6 Storm surges due to strong winds will flood coasts (2)
Damage to property because of flooding of low-lying coastal areas (2)
Loss of human life (2)
It will cause coastal erosion (2)
Destruction of transport infrastructure like harbours (2)
Ecosystems are disrupted (2)
Strong winds can damage property (2)
[ANY FOUR] (4 x 2) (8)

Map Work application on Tropical cyclones
Activity 7.4 Page 35 - 36

7.4.1 North West (1) (1 x 1) (1)

7.4.2 Low lying area, below 40 meters above sea level (2)
It is built on the floodplain (2)
It is build on marshland (2)
[Any TWO] (2 x 2) (4)

7.4.3 The circulation of the winds around the low pressure of a tropical cyclone in the Southern Hemisphere is clockwise. The winds will blow towards St Lucia from a South easterly direction (2) (1 x 2) (2)

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8. Subtropical Anticyclones and Associated Weather Conditions

Activity 8.1 Page 47

8.1.1 Air pressure decreases towards the centre/lowest value in the centre (1)

8.1.2 Along the west coast of South Africa (1)

8.1.3 Southwards/South-south-eastwards (1)

8.1.4 Fog (1)

8.1.5 20˚C (1)

8.1.6 Clockwise (1)

8.1.7 Berg winds (1) (7 x 1) (7)

Activity 8.2 Page 48

8.2.1 X (1)

8.2.2 South Indian High (1)

8.2.3 Indian Ocean (1)

8.2.4 Kalahari High (1)

8.2.5 Rising (1)

8.2.6 Y (1)

8.2.7 Strong (1)

8.2.8 Above (1) (8 x 1) (8)

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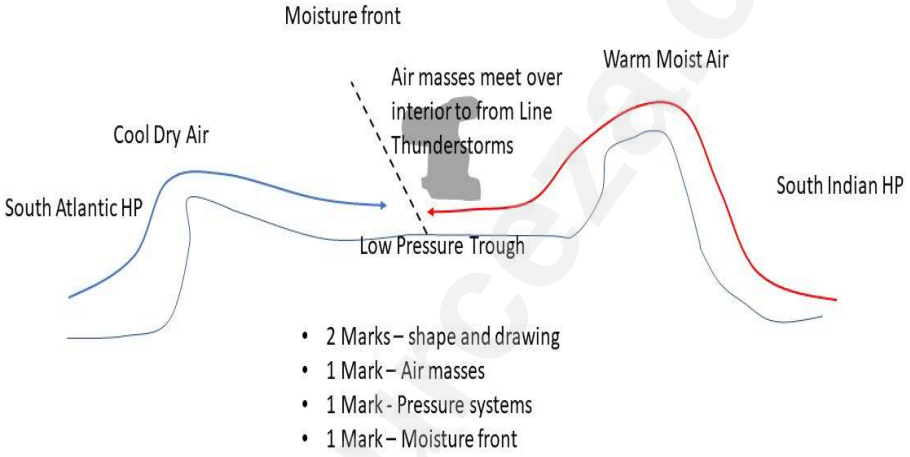
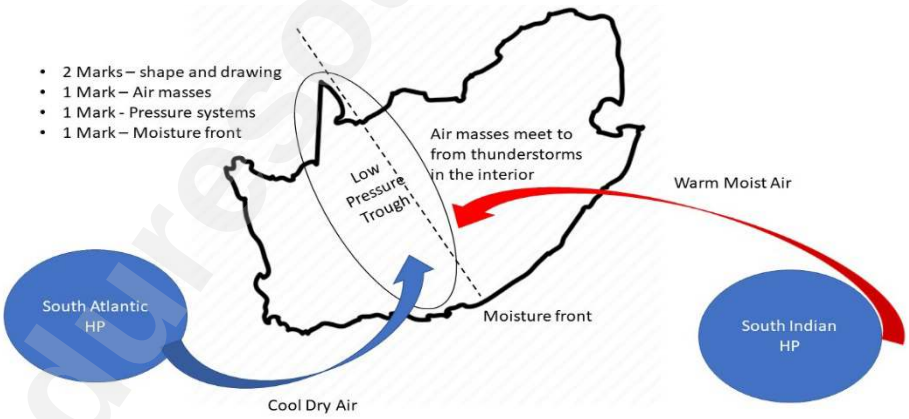
Activity 8.3 Page 49

8.3.1 Low-pressure trough/moisture front (1) (1 x 1) (1)

8.3.2 flash flooding/heavy rains/lightning (1) (1 x 1) (1)

8.3.3 The candidate must show an understanding of how line thunderstorms form over the interior of South Africa
They can either draw a synoptic view or a cross-section.
Marks given for:
shape and drawing (2)
air masses (1)
pressure systems (1)
moisture front/trough (1)





(5)

(5 x 1)

8.3.4 Low pressures over land during summer, draw in moisture off the oceans onto the land (2)
Inversion layer above the escarpment in summer allows inflow of moist air (2)
Weakened Kalahari High Pressure Cell facilitates greater vertical rising of air above the interior (2)
[Any ONE] (1 x 2) (2)

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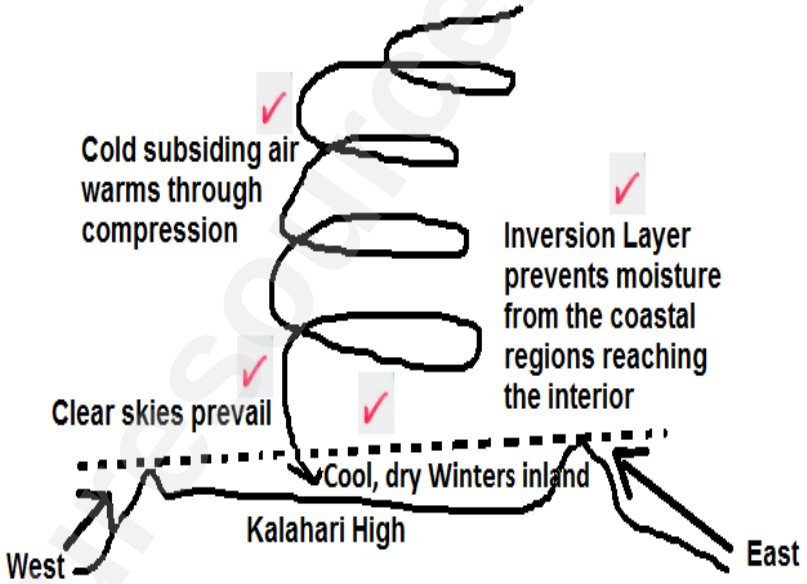
8.3.5 Warm moist air from the east reaches the interior, cold dry dense air from the west forces warm moist less dense air to rise and large scale condensation result in dense cloud formation (1 x 2) (2)

8.3.6 Line thunderstorms are more severe:
will have a strong up-draught/stronger upliftment/ rapid rising (2)
and condensation along the moisture front (2)
continuously feeding on moisture from the ocean (2)
are a collection of cells that move in the same direction (2)
consistent formation of cumulonimbus clouds along the moisture front. (2) (2 x 2) (4)

Activity 8.4 Page 50

8.4.1 A - South Atlantic Anticyclone (1)
B - Kalahari Anticyclone (1)
C - South Indian Anticyclone (1) (3 x 1) (3)

8.4.2



(4)

Air pressure decreases towards the centre/lowest value in the centre
[Source: DBE; Feb-March 2016] (4 x 1)

8.4.3 **<u>THE IMPACT OF ITCZ ON ANTICYCLONES</u>**
The Earth is tilted 23½° to the vertical, as it faces the sun (2)
This causes the ITCZ to shift north and south of the equator from season to season (2)
Pressure belts follow the apparent migration of the sun (2)
In summer the 3 anticyclones are located further south (2)
In winter the 3 anticyclones are located further north (2)
[Any FOUR] (4 x 2) (8)

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Map Work application on Subtropical Anticyclones and Associated Weather Conditions
Activity 8.5 Page 51

8.5.1 Southwards (1) (1 x 1) (1)

8.5.2 Weather in Cape Town is overcast t(2) (1 x 2) (2)

8.5.3 Green Point will experience onshore wind (2) is cold (2) and dry (2) with limited moisture.
[Any TWO] (2 x 2) (4)

9. Valley Climate
Activity 9.1 Page 57

9.1.1 thermal belt (1)

9.1.2 Smog (1)

9.1.3 Aspect (1)

9.1.4 radiation fog (1)

9.1.5 Frost (1)

9.1.6 Katabatic (1)

9.1.7 Anabatic (1)

(7 x 1) (7)

Activity 9.2 Page 58

9.2 Katabatic slope (1) (1 x 1) (1)

9.2.2 Temperatures are above freezing point. (1) (1 x 1) (1)

9.2.3 Temperature inversion (1) (1 x 1) (1)

9.2.4 Slope **A** is a South facing slope. (2)
South facing slopes in the Southern Hemisphere are cold. (2)
Cold descending air in contact with the slopes will cause temperatures to drop below freezing point. (2)
[Any TWO]. (2 x 2) (4)

9.2.5 Temperatures will be below freezing point because of cold descending air. (2)
A frost pocket will form as a result of temperatures below freezing point. . (2)

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Crops which cannot withstand frost will be planted on the North facing slope,where it is warmer. (2)
Frost resistant crops such as deciduous fruits will be grown on the valley floor. (2)
The cold conditions and frost kill pests (2)
Cold conditions suit the growing conditions of these crops (2) (8)
[**ANY FOUR**] (4 x 2)

Activity 9.3 Page 59

9.3.1 Katabatic ACCEPT Downslope wind/Gravity wind (1) (1 x 1) (1)

9.3.2 Cold air becomes dense and sinks (1)
Gravity (1)
Pressure differences at crest and valley floor/Pressure gradient (1)
[ANY ONE] (1 x 1) (1)

9.3.3 Friction (2)
Slows the downward movement of air (2)
[ANY ONE] (1 x 2) (2)

9.3.4 The dense, cooler air collects on the valley floor (2)
Warmer air is displaced upwards (2) (2 x 2) (4)

9.3.5 **Positive Influence on Valley Floor**
Radiation fog that covers the valley floor increases the level of moisture available to plants (2)
Melting frost is a source of water, keeps the soils moist (2)
Extreme cold kills unwanted pests (2)
The lower temperature promotes frost resistant types of vegetation (2)
Negative Influence on Valley
Floor Cold dense air collects on the valley floor creating frost pockets that destroys vegetation (2)
Air cools to below freezing point and frost covers plants and soil which weakens stems and leafs of vegetation (2)
Black frost can destroy plants (2)
Radiation fog formed on the valley floor at night reduces the level of photosynthesis in the mornings (2)
Reduces the variety of crops able to be grown; only frost resistant crops can be grown (2)
[**ANY FOUR**. MUST REFER TO BOTH POSITIVE AND NEGATIVE INFLUENCES] (4 x 2) (8)

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Map Work application Valley Climate
Activity 9.4 Page 60

9.4.1 Katabatic (1)
Downslope (1)
Gravitational wind (1)
Mountain wind (1)
[**Any ONE**] (1 x 1) (1)

9.4.2 The slopes cool down resulting in the air in contact with the slopes cooling down (2)
The cooler air becomes heavy and dense (2)
Cooler air subsides down the valley slopes (2)
Cooler air accumulates on the valley floor/trapped by inversion layer (2)
The cold subsiding air cools the temperature to below freezing point (2)
[**Any TWO**] (2 x 2) (4)

9.4.3 They are farming with frost resistant fruit (1)
Deciduous fruit e.g. apples, pears (1)
[Accept examples[(1 x 2) (2)

10. Rural and Urban Climate
Activity 10.1 Page 68

10.1.1 day (1)

10.1.2 lower (1)

10.1.3 increases (1)

10.1.4 multiple reflections of heat (1)

10.1.5 increases (1)

10.1.6 decreases (1)

10.1.7 less (1)

10.1.8 more (1) (8 x 1) (8)

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Activity 10.2 Page 69

10.2.1 Area of high temperatures in a city surrounded by areas of low temperatures (2) (1 x 2) (2)

10.2.2 When the build-up area absorbs and releases more heat because of building structures, glass and metal structures
factories and motor-vehicles, lack of open spaces which results in the atmosphere being warmer than the surrounding rural area. (2)
(1 x 2) (2)

10.2.3 CBD or city Centre. (1) (1 x 1) (1)

10.2.4 More open spaces and better air circulation due to fewer buildings. (2)
More vegetation ad trees to absorb the suns heat (photosynthesis). (2)
A poor and less-efficient drainage system – standing water absorbs heat and evaporates – cools the atmosphere. (2)
Buildings are constructed with natural materials (timber, mud, thatch) which do not absorb so much of heat. (2)
Surfaces are hardly concreted or tarred which means less heat absorbed and retained – more corrugated (untarred) roads and pathways. (2)
[**Any TWO**] (2 x 2) (4)

10.2.5 Establish greenbelt zones to limit expansion and develop other areas. (2)
Decentralisation of certain city functions – especially those requiring high pedestrian and vehicular traffic, e.g. chain stores, industries. (2)
Use of building materials that reduce temperatures such as reflective roof paints (2)
Establish roof gardens. (2)
Providing an efficient public transport system. (2)
[Any TWO] (4 x 2) (8)

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Activity 10.3 Page 70

10.3.1 An accumulation of dust, soot and smoke (pollution) particles over the city (1)
[CONCEPT] (1 x 2) (2)

10.3.2 Urban areas produce more pollution/combustion released by cars, industries and other activities/More human activities (2)
(1 x 2) (2)

10.3.3 During the night subsidence is stronger/trapped closer to the ground/ inversion layer is closer to the surface at night (2)
Less activity resulting in heat generation to lift pollution dome (2)
Pollution covers a smaller area (2)
Less convection/thermal currents to distribute pollution at night (2)
[ANY TWO] (2 x 2) (4)

10.3.4 Soot accumulation on buildings results in more cleaning services needed (2)
Results in acid rain which results in peeling of paint of buildings (2)
Buildings must be painted more often (2)
Concrete surfaces become pitted (holes) and must be maintained/renovated more frequently (2)
Metal structures such as metal window frames/air conditioners become corroded because of the acid rain/renovated more often (2)
Replacing damaged material with good quality/durable material is costly (2)
Regular replacement/purchase of air conditioner filters (2)
More regular painting of road markings as acid rain makes it peel easier (2)
High pollution results in higher rainfall and can cause flood damage (2)
Damaged plants in gardens to be replaced (2)
Water reservoirs/dams become polluted and money spent to purify water (2)
[ANY FOUR] (4 x 2)
(8)

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Map Work application Rural and Urban Climate
Activity 10.4 Page 71

10.4.1 Answer: Seasonal (1) (1 x 1) (1)

5.4.2 Reason: Large number of non-perennial rivers/water (1)
Irrigation is practiced as indicated by dams/furrows/wind pumps (1)
Many reservoirs/storage dams visible on the topographic map (1)
Experiences continental climate (1)
Mapped area is sparsely vegetated (1) (2)
(**Any ONE)** (1 x 2)

10.4.3 (a) Identify TWO factors evident in block **G5** that could reduce the temperature in Ratlou.
The river (2)
The green areas/greenbelts/parks (2)
Recreational areas (2)
(**Any ONE)** (2 x 1) (2)

(b) Explain how ONE of these factors mentioned in QUESTION 5.4.2 (a) reduces the temperature in Ratlou.
The river: Absorb a lot of heat due to it being transparent (2)
Will have a moderating effect on the temperature (2)
Evaporation from the river has a cooling effect (2)
(Any ONE)

OR

The green areas/recreational areas/greenbelts/parks:
Absorb a lot of greenhouse gases/carbon dioxide (2)
Plants absorb a lot of heat for photosynthesis (2)
Evapo-transpiration has a cooling effect (2)
Green areas provide shade which has a cooling effect (2)
Natural surfaces are cooler than artificial surfaces (2)
(**Any ONE**) (1 x 2) (2)

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12. ANNEXURE A: EXAMINATION ACTION VERBS

ACTION WORDS (VERBS/COMMAND WORDS) FOR ASSESSMENT

VERB	MEANING	HOW TO ANSWER
Account	to answer for - explain the cause of - so as to explain why	Full sentences
Analyse	to separate, examine and interpret critically	Full sentences
Classify	to divide into groups or types so that things with similar characteristics are in the same group - to arrange according to type or sort	One-word answers /phrases
Comment	to write generally about	Full sentences
Compare	to point out or show both similarities and differences	Full sentences
Define	to give the concise and clear meaning	Full sentences
Describe	to list the main characteristics of something - give an account of	Full sentences
Differentiate	to show the difference between things	Full sentences
Discuss	to examine by means of argument, presenting both sides and reaching a conclusion	Full sentences
Determine	to officially decide (something) especially because of evidence or facts	Full sentences
Distinguish	to recognise the difference between things	Full sentences
Draw / Sketch	to show by means of a sketch	A diagram is required
Evaluate	to make an appraisal or express an opinion concerning the value - to define, analyse and discuss	Full sentences
Explain	to make clear, interpret and spell out the material you present	Full sentences
Give	to state facts without discussions	One-word answers
Identify	to give the essential characteristics of - to name	One-word answers
Illustrate	to show what something is like - to show that something is true	Full sentences
Justify	to prove or give reasons for decisions or conclusions, using logical argument	Full sentences
List	to write an itemised series of concise statements	One-word answers
Locate	to find the exact place where something is	One-word answers
Mention	providing relevant facts	Full sentences
Name	to state something - give, identify or mention	One-word answers
Outline	give a summary, using main points and leaving out minor details	Full sentences
Predict	to say what you think will happen - to foretell - to say in advance	Full sentences

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VERB	MEANING	HOW TO ANSWER
Propose	to suggest a plan - to make a formal suggestion	Full sentences
Provide	to state facts without discussions	Full sentences/one-word answers
Recommend	to advise that something should be done	Full sentences
Report	to produce an official statement or written document	Full sentences
Select /Choose	to choose something from a greater whole	One-word answers
Solve	to find a solution to something that is causing difficulties	Full sentences
State	to present information plainly without discussion	One-word answers
Suggest	to propose an explanation or solution	Full sentences
Support	to show that an idea/statement is true	Full sentences
Tabulate	to group like terms or activities under specific headings	One-word answers/phrases
Use	to do something using a specific skill or method	Full sentences
Verify	to check/prove that something is correct	Full sentences
Write	to create a formal document	Full sentences

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