MODULE 1

CLIMATE AND WEATHER

This module includes the following topics:

- Mid-latitude cyclones
- Tropical cyclones
- Subtropical anticyclones
- Valley climates
- Urban climates
- Interpretation of synoptic weather maps

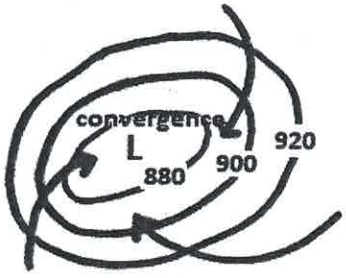
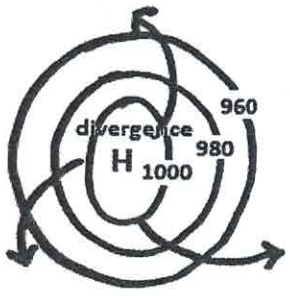
KEY CONCEPTS

Anticyclones	High pressure systems/cells.
Convergence	Flow of air into a low pressure system
Cyclones	Low pressure systems/cells. Also called depressions.
Dissipation	Decay of a low pressure system or cyclone - when it ceases to exist.
Divergence	Flow of air out of a high pressure system
Heat island	An area of higher temperature surrounded by lower temperatures in a city.
Mid-latitude Cyclones	Frontal low pressure cells forming in westerly wind belt from 30°- 60° N/S.
Moisture Front	Zone along which warm, moist air meets with cold, dry air and is uplifted. Line thunderstorms occur along the moisture front.
Polar Front	Zone along 60^0 N/S where warm sub-tropical air and cold polar air meet
Cyclone families	Refers to a group of mid-latitude cyclones that pass over an area in quick succession.
Synoptic Weather Map	Summary of weather conditions of a place/region for one day.
Tropical cyclones	Intensely developed low pressure systems associate with severe storms.
Berg winds	Hot, dry and gusty wind that is local to South Africa.
Anabatic Winds	Winds that are forced upslope in a valley by descending cold air (day).
Aspect	Angle at which the sun's rays strikes a slope.
Katabatic Winds	Downslope flow of winds in a valley due to force of gravity at night.
Radiation Fog	Low level condensation in valley due to temperature dropping below DPT.
Temperature Inversion	Increase in temperature with altitude (warm air rises to lie above cold air). .
Micro climate (local)	Study of climate in a small area e.g. a valley
Dust dome	Pollutants, dust, suet and smoke that subsides over the city at night.
Cold Front	Moving mass of cold air
Warm Front	Moving mass of warm air

Origin of low and high pressure cells

They originate due to differences in the way that land and water masses heat or cool at different latitudes. This then causes high and low pressure belts to break up into pressure cells.

Pressure cells are generally represented by circular isobars on synoptic weather maps.

Low pressure cell (Cyclone)	High pressure cell (Anticyclone)
	
• **Associated with warm, rising air** (summer) • Convergence[1] occurs in a low pressure cell. • Lowest pressure is found in the centre. • Air moves in a **clockwise direction in the southern hemisphere** and in an anticlockwise direction in the northern hemisphere. • Associated with **unstable weather** conditions (rain, wind)	• **Associated with cold, subsiding air** (winter) • Divergence[2] occurs in a high pressure cell. • Highest pressure is found in the centre. • Direction of air movement is **anticlockwise in the southern hemisphere** and clockwise in the northern hemisphere. • Associated with calm, clear and **stable weather** conditions.

- **Low pressure cells** can be identified by the letter **L** in the centre **or** the lowest pressure reading in the centre.
- **High pressure cells** can be identified by the letter **H** in the centre **or** the highest pressure reading is found in the centre.

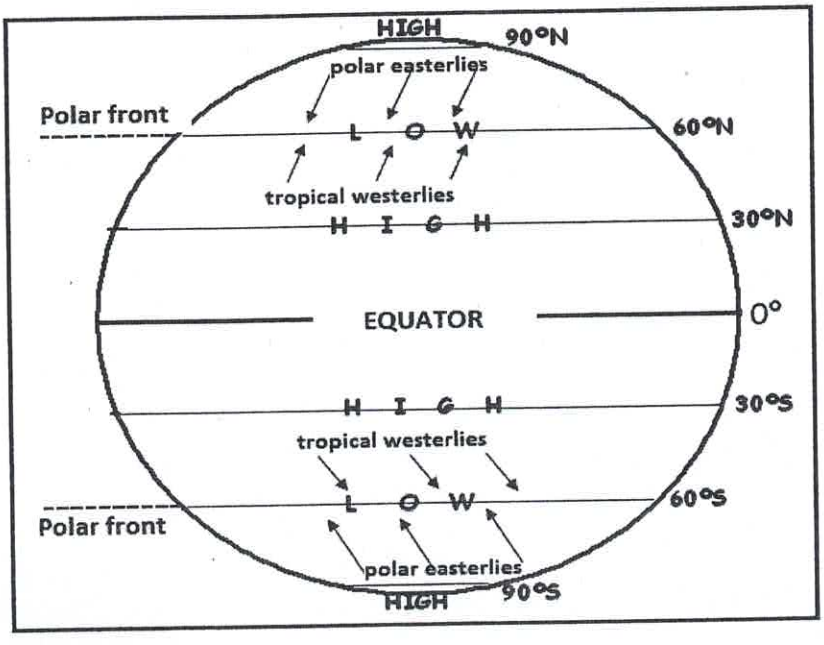
[1] Convergence: movement of air into a low pressure cell
[2] Divergence: movement of air away from a high pressure cell

MID-LATITUDE CYCLONES

Origin

They originate when **warm tropical westerly winds** (30°N/S) meet the **cold polareasterly winds**(90° N/S) at the **polar front**.

The **polar front** occurs at the 60° N/S latitude.



Alternate names

Temperate cyclones, frontal depressions and extra-tropical cyclones.

General Characteristics

- They **occur between the 30° to 60° N/S latitudes**.
- **Move from west to east** or eastwards
- **Steered by the westerlies** in the westerly wind belt.
- Temperate cyclones consist of fronts – **(warm and cold fronts)**.
- **Size**: They are very large cyclones- with a diameter of about 1 000 km.
- Occur throughout the year but **affects South Africa mainly in winter**.
- It lasts between 4 to 14 days.

Conditions necessary for Formation

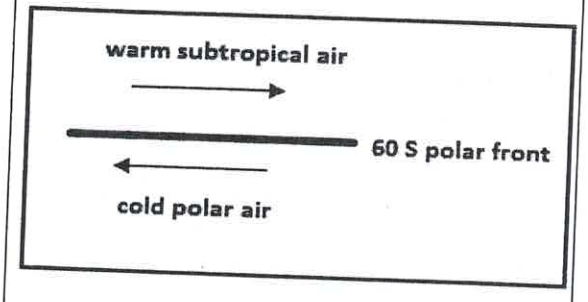
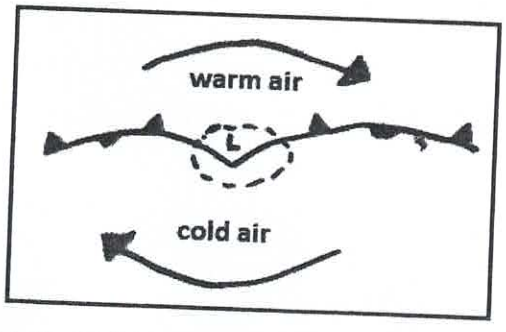
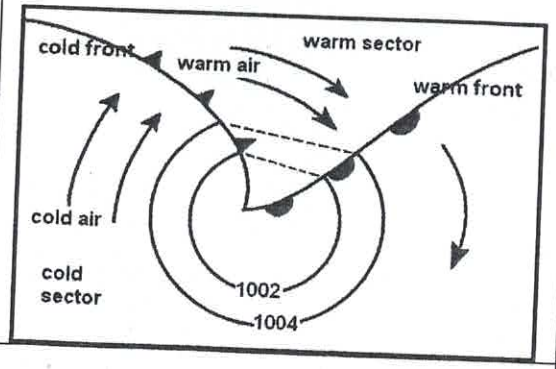
1. **Warm** sub-tropical air (from 30° N/S) meets with **cold** polar air (from 90° N/S) at the Polar Front (60° N/S).
2. Both air masses move parallel to each other in **opposite directions**.

3. **Frictional drag** between the air masses causes them to interact with each other. This frictional drag occurs as a result of:

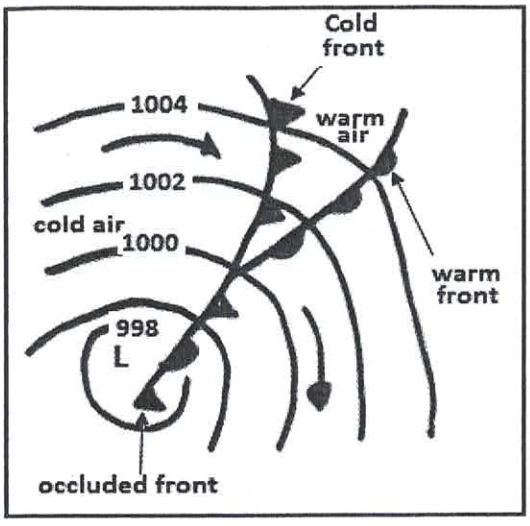
   a. differences in the speed at which both air masses move
   b. an uneven surface over which they move
   c. **temperature differences between land and sea surface.**

Stages in the Formation of Mid-Latitude Cyclones

Cyclogenesis refers to the variousstages of development of a cyclone. **Four stages**occur.

1. ***Initial Stage***  **NB.** The polar front is also referred to as the stationary front.	• Warm tropical air from 30° S and cold polar air from 90° S converge at polar front (60°S). • Coriolis force deflects both air masses in the southern hemisphere towards the**left** causing them to move parallel to each other in opposite directions.
2. ***Wave Formation***  	• The wave stage occurs when frictional drag takes place between the two air masses. • A **wedge of warm air begins to be uplifted by the cold air.** • Fronts begin to form as air converges in a clockwise direction in the Southern hemisphere towards the low pressure centre.
3.Mature Stage  	• The wave deepens or intensifies and isobars at the fronts kink and point away from the low pressure. • The **cold and warm fronts**and sectors are fully developed in a **well formed V shape.** • Cooling, condensation, cloud formation and rain are associated with the rising air. • The cold front is associated with towering cumulonimbus clouds and the warm front with a broad band of stratus clouds.

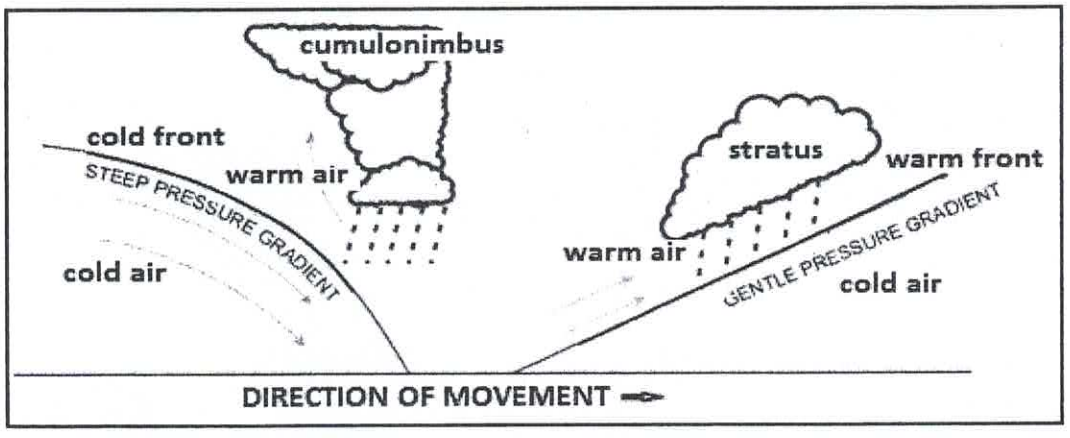
3. ***Occlusion Stage***



- This stage is reached when the **cold front catches up with the warm front** at the apex because the cold air (heavy, dense) moves faster than the warm air.
- **Occlusion** starts at the **apex** because it is the **shortest distance between the two fronts**. An occlusion can either be a warm or a cold front occlusion.
- A **cold front occlusion** takes place when the coldest air is found ***behind*** the cold front, and this causes the warm air to be uplifted along the cold front. The cold front undercuts the warm front.
- A **warm front occlusion** takes place when the coldest air is found ***ahead*** of the warm front and this causes the cold air to be uplifted along the warm front.

When all the warm air has been uplifted the cyclone is in the dissipating or degenerating stage

Cross section through a mid-latitude cyclone



Cumulonimbus clouds form at the cold front because of a steep gradient which results in the intense uplift of air.

Weather associated with the passage of a mid-latitude cyclone

As each sector of the mid-latitude cyclone moves over an area, there is a change in weather.

In **winter** the mid-latitude cyclone migrates northwards (with the apparent movement of the sun) thus having a greater impact over the land. In **summer** however they migrate southwards and have very little or no impact on the weather over the land.

The **warm front** generally has little effect on SA because it moves too far south of the country.When the **South Atlantic High ridges** in behind the cold front, more old air is brought in and this resultsin very heavy showers and snow.

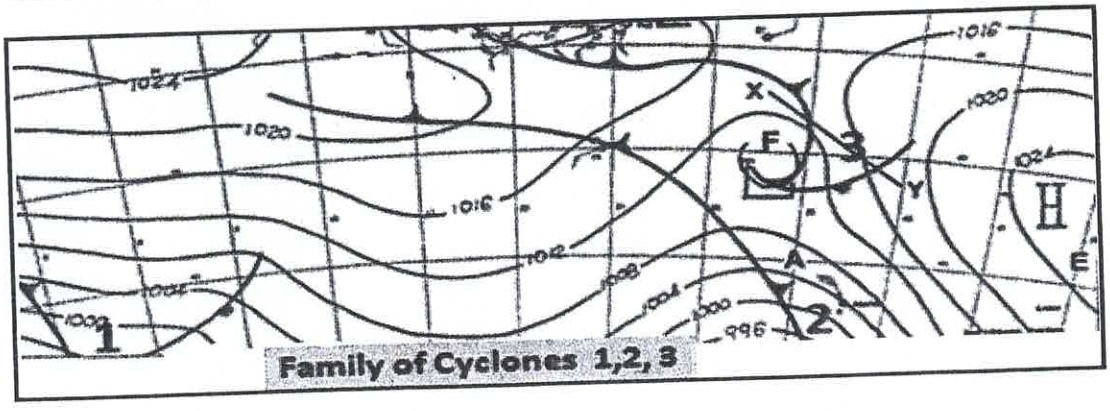
NB:

- A change in wind direction in mid-latitude cyclones to the left (anticlockwise in SH) is called **backing** and a change to the right (clockwise in the NH) is called **veering**.
- When the cold front passes an area the **pressure drops** because the air to the rear (back) of the front is colder than the front.

Element of weather	Cold front approaches	Cold sector	Warm sector	Warm front approaches
Temperature	Drops rapidly	Low temperatures	Air is warm	Temperature rises
Winds	Strong ,gusty and backs	Pressure rises	Becomes steady	Increase and backs
Air pressure	Steep rise in pressure	Pressure increases	Drops	Pressure drops
Humidity	Decrease in humidity	Decrease in humidity	High humidity	Humidity increases
Precipitation	Thunderstorms and hail are common	Heavy showers occur	Light rain that decreases	Soft rains occur

Cyclone Families

Mid-latitude cyclones do not occur in isolation.They formin groups in the west wind belt andmove eastwards. Sometimes as many as four or five pass through a certain area in quick succession and are visible on a synoptic weather map. These are called '**cyclone families**'.



Family of Cyclones 1,2, 3

Impact of Mid-latitude cyclones

- The cold front brings **winter rainfall** to the South Western Cape and this is ideal for **vineyards and deciduous fruit** cultivation.Sometimes the heavy downpours associated with the approaching cold fronts cause serious **floods that damage** property and crops.
- When the cold front approaches it may result in the formation of **snow** on the Cape Fold Mountains. Crops are damaged and livestock killed. However, snowfalls over the mountains **attract tourists** thus boosting the economy.
- During frontal storms, strong winds and high seas occur posing a **hazard to fishermen** in the South Western Cape.

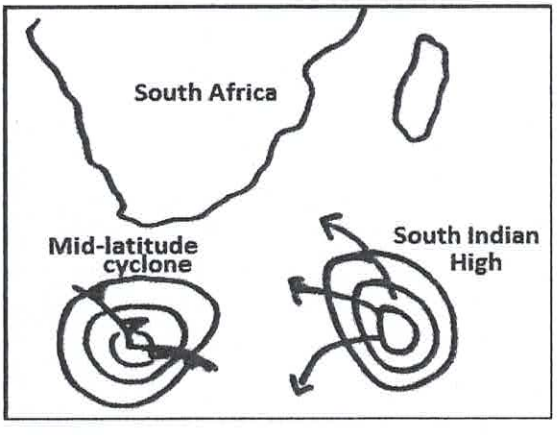
Precautionary and management strategies

- Construction of houses and infra-structure should be avoided **in low-lying areas** to prevent the threat of floods.
- An **efficient drainage system** in urban areaswill reduce flooding risks.
- **Livestock,** e.g. sheep, should be placed in a kraal, shed or any other enclosed area to prevent losses during severe snowfalls.
- Farmers should have **sufficient grain and fodder** to minimise/prevent livestock loss.
- It is important to keep **updated on weather conditions** in winter before planning hikes and other outdoor activities
- Do not venture out into the open sea during frontal weather. **Secure fishing vessels** to the harbours and keep track of the weather via TV or radio before attempting to go out.
- As **visibility is very poor**, minimise driving and remain indoors until weather clears (cold front passes).
- Danger from **rock falls** is also increased at this time resulting in loss of life, injury and damage to property.
- **Stock up timeously on essentials** (batteries, food, fuel, medication) as electricity blackouts, loss of communication channels and shorter trading hours is common during this time.

Effect of the South Indian High on the passage of the mid-latitude cyclone

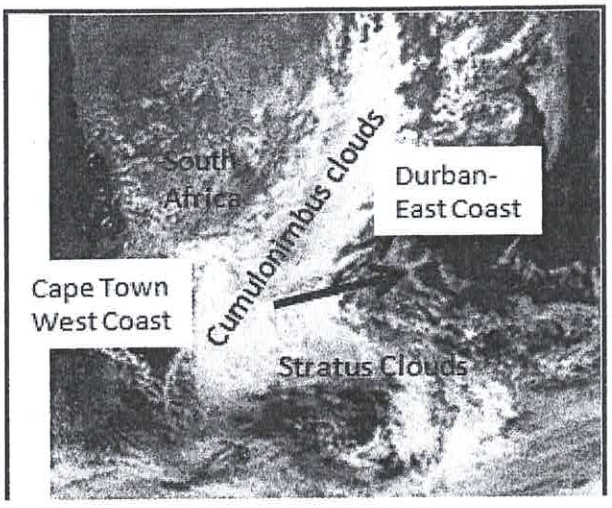
The general direction of movement of the mid-latitude cyclone is **west to east or easterly**.
However, sometimes the South Indian High may be in the path of an approaching mid-latitude cyclone.

This causes the cyclone to move further south, and later towards the east where it dissipates over the Indian Ocean. In this instance the South Indian High is known as a **blocking high.**



Satellite image of mid latitude cyclone over South Africa

Can be identified by clouds that are roughly V-shaped which indicates the presence of the cold and warm front



The difference between a successful person and others is not a lack of strength, or knowledge, but rather in a lack of will.

ACTIVITY 1.1

1. **Choose the correct answer from within brackets to make the following statements true.**

a. A mid-latitude cyclone is also known as a (coastal low pressure/extra-tropical cyclone).

b. The mid-latitude cyclone in the figure develops in the (Southern/Northern) Hemisphere.

c. A mid-latitude cyclone is a (high/low)-pressure system.

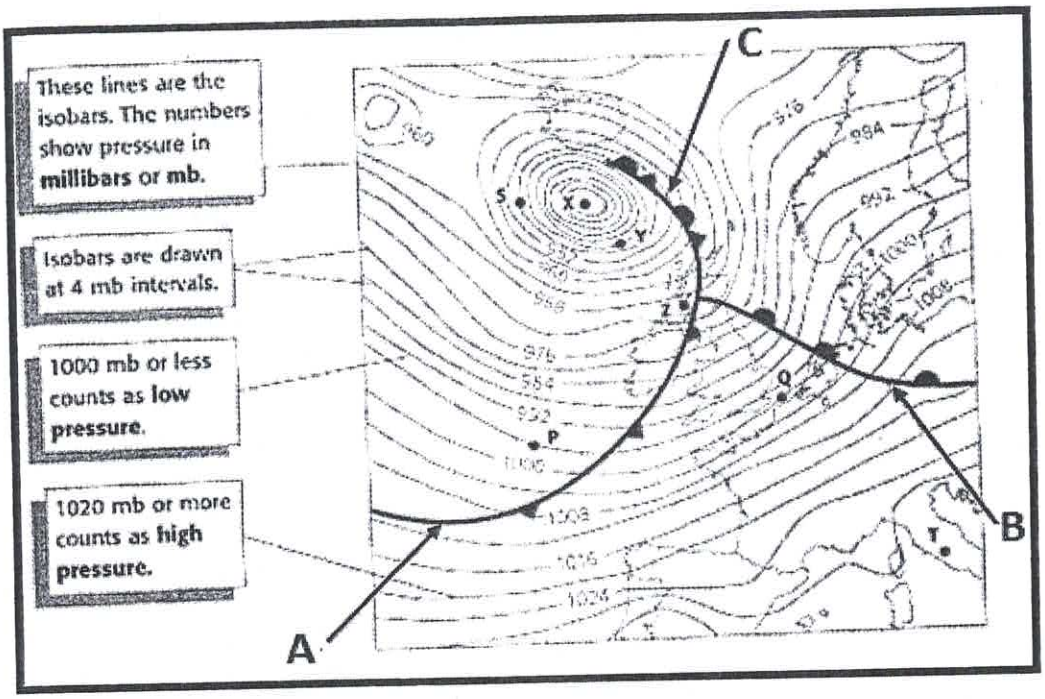
d. The stage of the cyclone when the cold front catches up with the warm front is the (dissipating/matur

e. A mid-latitude cyclone moves in a/an (easterly/westerly) direction.

f. A mid-latitude cyclone has a greater influence in South Africa in (summer/winter).

2. **The synoptic extract below shows a depression in the northern hemisphere.**

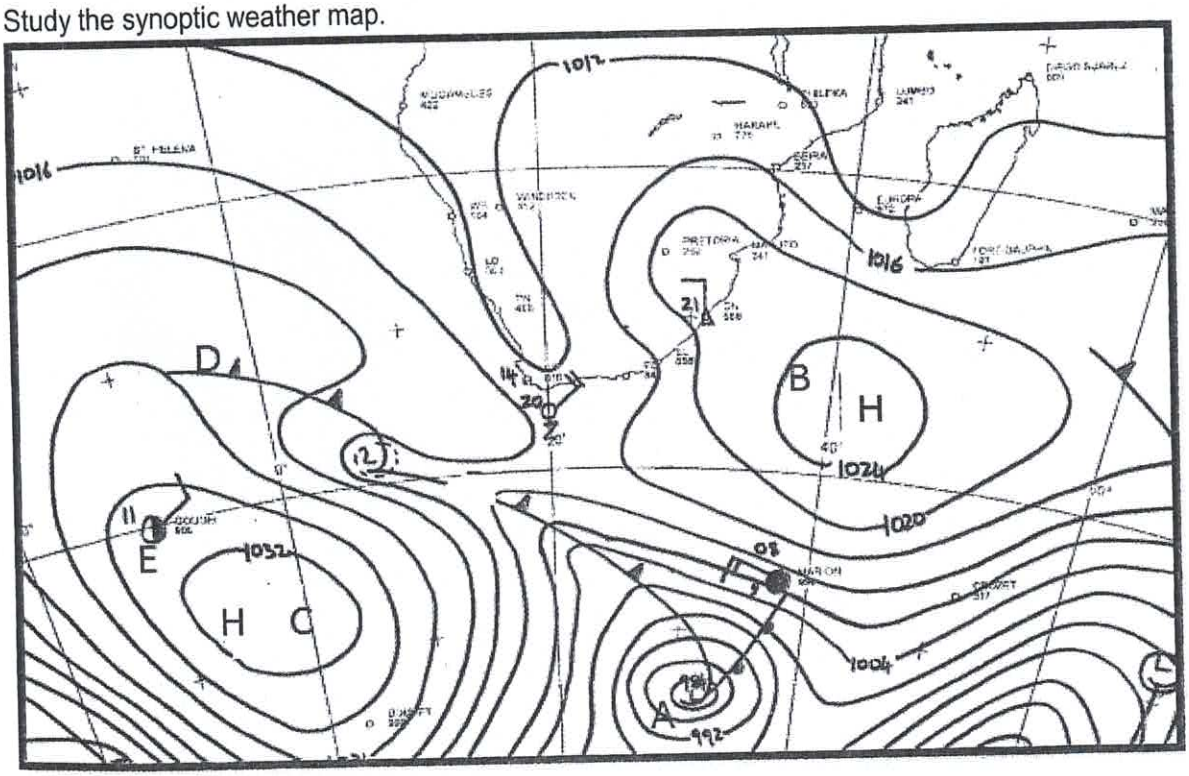
2.1 Name the fronts labelled **A, B** and **C**.
2.2 What are isobars?
2.3 State the pressure at **P** in millibars.
2.4 Which letter indicates the lowest pressure on the map?
2.5 Which area is likely to be warmer **P** or **Q**? Give a reason.
2.6 Are heavier wind speeds going to be experienced at **S** or **T**? Explain.
2.7 State two air movements associated with a depression.



2.8 Of what significance is front **A** to farmers?
2.9 Explain why the cyclone occludes from the apex.
2.10 Draw a labelled cross-section between **A** and **B**.

ACTIVITY 1.2

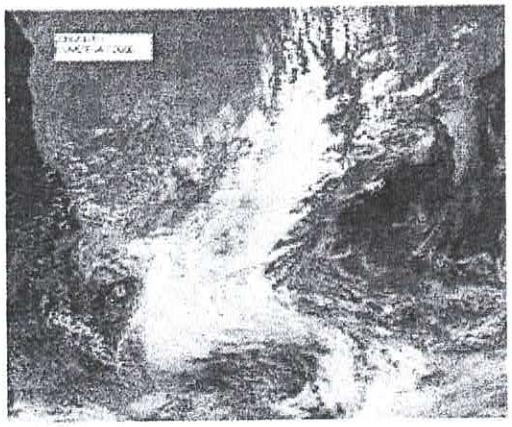
Study the synoptic weather map.



1. Identiy the pressure systems labelled: **C** and **B**.
2. What suggests that the map represents winter conditions in the southern hemisphere?
3. Name the front labelled **D**.
4. State any 3 characteristics of cyclone **A**.
5. Explain the role of anticyclone B on the movement of cyclone **A**.
6. Cape Town is experiencing clear skies and winds of only 15 knots/hr. Is this about to change in the next 24 to 48 hours? Give a reason (evident from map) for your answer.
7. How will the weather phenomenon **A** impact on fishing vessels to the south of the country?
8. When will this cyclonic weather system decay?

ACTIVITY 1.3

Refer to the satellite image:



1. The atmospheric disturbance represented by the satellite image is a .....
2. Label and illustrate a cross-section of the fronts in the image.
3. Briefly describe the formation of the cold front in the system.
4. Describe the weather being experienced over the eastern parts of South Africa as shown in the image.
5. Draw a weather symbol to indicate the weather that will be experienced inDurban.

ACTIVITY 1.4

Read the case study before attempting the questions set:

1. Name the cyclone responsible for the heavy rains in Cape Town.
2. Describe with reasons why a flood alert has been issued by the authorities?
3. What precautions do you think Solomons-Johannes may have issued to the locals to reduce the loss of lives and damage to property?
4. Aside from torrential rains and the threat of floods, what other weather changes may be experienced by the residents?
5. Explain why informal settlements are likely to be more affected than urban residents in the region.
6. Many residents await such weather conditions annually in the Cape Town area. Give a reason for this.