1.3 What is the composition of the atmosphere?

The following table summarises the gases in the atmosphere, the amount of each in the atmosphere, as well as its importance for life on Earth.

Gases in the atmosphere and their significance

Type of gas	Gas	Percentage by volume	Importance for weather and climate	Other functions/source
Constant gases	Nitrogen (N_2)	78.09	• Mainly passive	• Needed for plant growth
	Oxygen (O_2)	20.95		• Produced by photosynthesis; reduced by deforestation
Variable gases	Water vapour (H_2O)	0.03 (can rise to 4.0)	• Source of cloud formation and precipitation; reflects/absorbs incoming radiation; keeps global temperatures constant	• Essential for life on Earth; can be stored as ice/snow
	Carbon dioxide (CO_2)	0.03	• Absorbs long-wave radiation from the Earth and so contributes to 'greenhouse effect'; its increase, due to human activity, is a major cause of global warming	• Used by plants for photosynthesis; increased by burning fossil fuels and by deforestation
	Ozone (O_3)	0.00005	• Absorbs incoming ultraviolet radiation	• Reduced / destroyed by chlorofluorocarbons (CFCs)
Inert of noble gases	Argon (Ar)	0.93	•	•
	Helium (He), neon (Ne), Krypton (Kr)	Trace	•	•
Non-gases	Dust, salt and smoke particles	Trace	• Absorb/reflect incoming radiation; form condensation nuclei necessary for cloud formation	• Come from volcanoes, meteorites, soil erosion by wind
Pollutants	Sulphur dioxide, methane	Trace	• Affect radiation; cause acid rain	• From industry, power stations and car exhausts

1.4 What is the structure of the atmosphere?

- Four distinct layers make up the atmosphere's structure.
- Three of these layers are found in the homosphere (troposphere, stratosphere and mesosphere); one is found in the heterosphere (thermosphere).
- Homosphere (±80 km above the Earth's surface)
- Constant gases (fixed mixture)
- Nitrogen (78,09%), oxygen (20,95%), inert/noble gases (0,93%)
- Variable gases (varied mixture)
- Heterosphere (>100 km above the Earth's surface)

1.4.1 What are the layers of the atmosphere, from Earth's surface upwards?

Troposphere

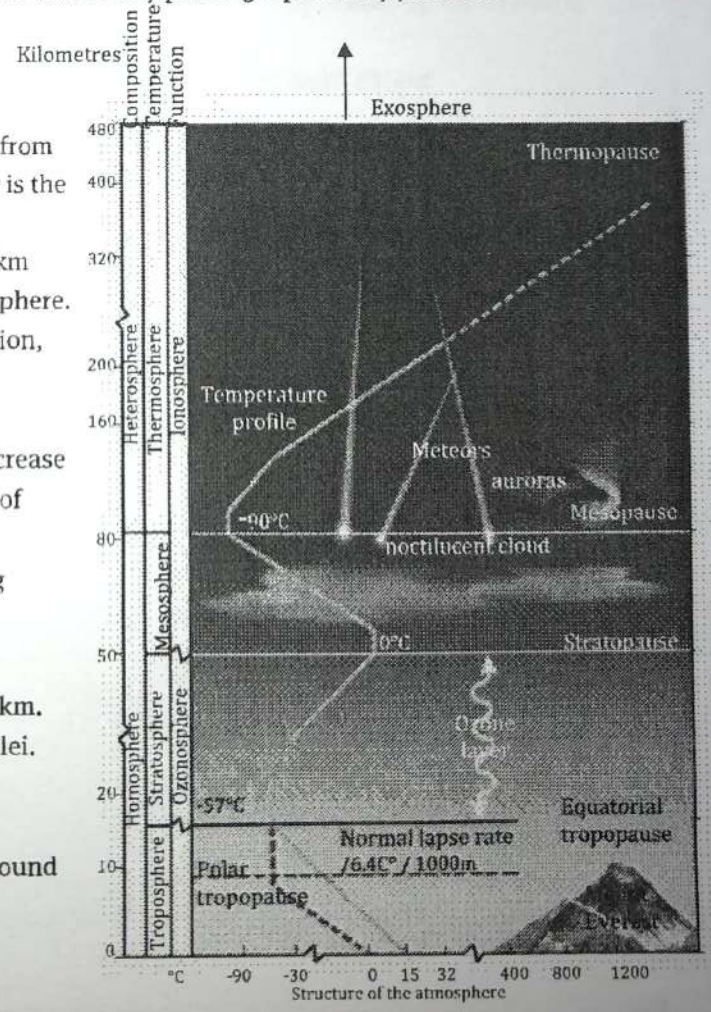
- The troposphere is the layer directly above the Earth's surface.
- It extends up from surface for 12 km. The upper boundary of the layer is the tropopause.
- It is warmed by the Earth's long-wave radiation, and processes like conduction and convection.
- The temperature decreases with increasing altitude at average rate of 6,4°C/1000 m. This is called the environmental/normal lapse rate.
- All weather processes take place in this layer. This is why passenger planes fly just in the tropopause.
- Air pressure falls with height.

Stratosphere

- The stratosphere layer extends in altitude from 12-50 km. The upper boundary of the layer is the stratopause.
- The ozone layer is situated between 15-35 km above the ground and is called the ozonosphere. Ozone absorbs incoming ultraviolet radiation, which may be harmful to humans, other animals and plants.
- The stratosphere is characterised by an increase in temperature caused by a concentration of ozone.
- It acts as protective layer against incoming meteorites.

Mesosphere

- The mesosphere layer extends from 50-80 km.
- It receives meteoric dust, which forms nuclei.
- Noctilucent clouds form from ice crystals.
- Temperature falls rapidly, with lowest temperatures of -90°C. Ice crystals form around nuclei. Strongest winds are recorded.



Structure of the atmosphere

Thermosphere

- The thermosphere is the uppermost layer of the atmosphere, from 80-480 km. Uppermost boundary is the thermopause.
- There is a rapid increase in temperature with increase in height, to 1500°C.
- Solar radiation is absorbed by atomic oxygen.

1.5 The ozone layer in the atmosphere

Highest concentrations of ozone are found between 15-35 km above the Earth's surface, in the stratosphere. Under natural conditions ozone is formed and destroyed all the time. Ozone absorbs the harmful ultraviolet (UV) rays from the Sun. (Also look at the other types of rays from the Sun in figure 40 on page 52 in the Learner's Book.)

Ozone depletion, together with a number of unusual climatic conditions, cause an 'ozone hole' over Antarctica. It is most noticeable in spring because of more intense heating in the Southern Hemisphere.

Composition and structure of the atmosphere

As a geography learner, you often will be required to make connections between different types of information and/or data.

You will be required to understand **cause and effect relationships**, as in this case of **ozone depletion.**

Such relationships will reappear when you study the greenhouse effect, global warming and weather shown on the synoptic chart.

Causes

Human activities are destroying ozone more rapidly than it is being formed. The main gases responsible for this are the release of:

- *chlorofluorocarbons* (CFCs) in aerosols, air conditioners and refrigerators
- *halons* in fire extinguishers
- *carbon tetrachloride* in solvents and cleaning agents
- *methane* from burning fossil fuels, and also emitted by animals and wetlands
- *methyl bromide* used in pesticides.

DEPLETING

THE OZONE LAYER

Effects

Increase in skin cancer and in leather-like skin

Increase in eye diseases, for instance cataracts

Weakens immune systems

Disrupts marine food chains

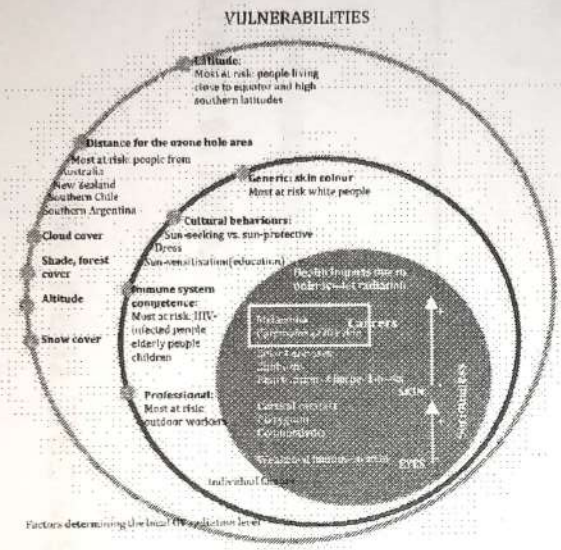
Damages plastic

Causes an increase in smog

Reduces photosynthesis, water-use efficiency, dry matter production in crops

1.6 Ways to reduce ozone depletion

How can the issue of ozone depletion be addressed? You can only start to deal effectively with the issue when you first have a good understanding of your own vulnerabilities and what factors influence the impact of ozone depletion



Application is important in geography. You always will get diagrams and pictures that you will be required to decode (making them easier to understand).

Illustrations like these give a lot of information or data that needs correct interpretation.

- *Can you identify the two main types of factors that make people vulnerable to ultra violet radiation?*
- *Can you identify the main health impacts?*

Read the information and data carefully and identify the key parts of the illustration and key headings or highlighted words. Then you will be able to summarise the illustration in your own words, or even illustrate it differently so that you understand it

Factors determining the local UV radiation level	Individual factors determining own exposure to UV radiation	Health impacts if at risk
Latitude, altitude Distance from the ozone hole Cloud cover Shade or forest cover, snow cover	Genetic skin colour Cultural behaviour Immune system competence Profession	Sun burn Cancer Leather skin

Unit 2 Heating of the atmosphere

2.1 Temperature changes over space and time

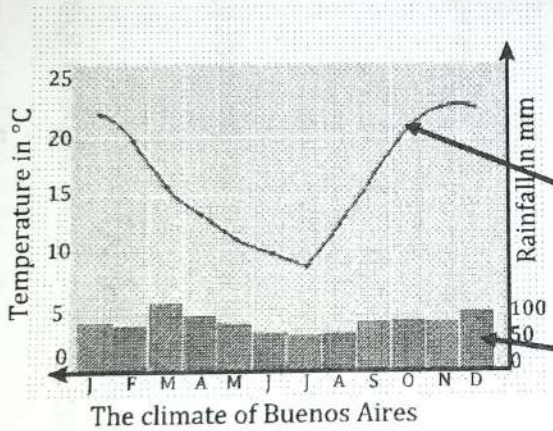
2.1.1 Over space

Temperatures vary over the Earth's surface.

- Hot at the equator
- Cold at the poles

2.1.2 Over time

- As you should know by now, night and day temperatures differ.
- Different seasons also have different temperatures.
- Temperature thus changes over time, as can be seen in the climate graph below.



The climate of Buenos Aires

A climate graph shows two graphs on one illustration.

The line graph shows the average temperature pattern for the year.

The bar graph shows the average rainfall pattern for the year.

2.1.3 Temperature variations at a place occur at three scales

Scale 1: Advection	Scale 2: Diurnal/daily	Scale 3: Seasonal variations
Advection is due to the horizontal movement of cold or warm air masses. Effect is illustrated by conditions experienced in Berg wind conditions in South Africa.	Mostly influenced by the region's situation and climate. Coastal areas – maritime climate – sea moderates climate – smaller temperature range. Inland areas – continental climate – absence of moderating effect of the sea – larger temperature range and more extreme temperatures.	Higher average temperature in summer – in December in the Southern Hemisphere. Lower average temperature in winter – in June in the Southern Hemisphere. The opposite situation will be experienced in the Northern Hemisphere.

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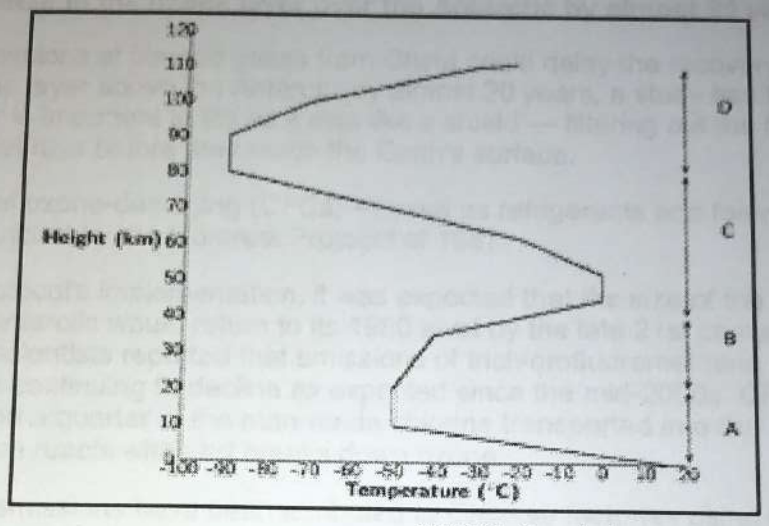
CURRICULUM AND ASSESSMENT POLICY STATEMENT

THE ATMOSPHERE: TERM ONE

ACTIVITY 1.1

MARKS 15 **TIME 15 MINUTES**

1.1. Refer to the diagram below showing the layers of the atmosphere and answer the questions set.



SOURCE: Google image

1.1.1. Define the term '*atmosphere*'. (1x1) (1)

1.1.2. Identify layers **A** and **C** respectively (2x1) (2)

1.1.3 Which gas constitute the most percentage in the atmosphere (1x1) (1)

1.1.4. Mention the layer that is found in the stratosphere that acts as a sunshield against ultraviolet rays (UV). (1x1) (1)

1.1.5. Explain the relationship that exists between temperature and height at layer **D**. (1x2) (2)

1.1.6. Discuss any TWO climatic importance of layer **A**? (2x2) (4)

1.1.7. Suggest TWO reasons why long-distance air crafts usually fly in the lower layer of the stratosphere. (2x2) (4)

[15]

ACTIVITY 1.2

MARKS 15 **TIME 15 MINUTES**

1.1. Read the following article based on ozone depletion and answer the questions that follow.

Mysterious rise in banned CFC gas emissions from China could delay the healing of the hole in the ozone layer over the Antarctic by almost 20 years

Unexpected emissions of banned gases from China could delay the recovery of the hole in the ozone layer above the Antarctic by almost 20 years, a study has found. The ozone layer is important to life as it acts like a shield — filtering out the Sun's harmful ultraviolet rays before they reach the Earth's surface.

The production of ozone-damaging (CFCs) — used as refrigerants and foaming agents — is restricted by the Montreal Protocol of 1987.

Following the protocol's implementation, it was expected that the size of the ozone hole above the Antarctic would return to its 1980 level by the late 21st century. In 2018, however, scientists reported that emissions of trichlorofluoromethane (CFC-11) had not been continuing to decline as expected since the mid-2000s. CFC-11 contributes around a quarter of the man-made chlorine transported into the stratosphere which reacts with and breaks down ozone.

The unexpected emissions have been attributed to Chinese factories using the banned chemicals in the production of insulating foam.

According to the experts, however, the impact of the emissions has been limited so far - and their rapid halt could reduce the delay in the hole's recovery to a few years.

MailOnline 2019

1.1.1. What is meant by *ozone depletion*? (1x1) (1)

1.1.2. Write CFCs in full. (1x1) (1)

1.1.3 According to the case study, what world summit addressed the issue of the production of ozone-damaging CFCs? (1x1) (1)

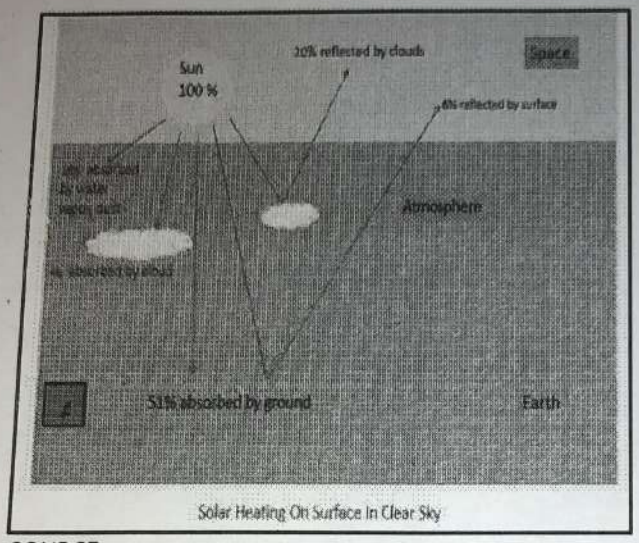
1.1.4. Explain TWO possible reasons why the natural recovery of the hole in the ozone layer is being delayed. (2x2) (4)

1.1.5. In a paragraph of approximately EIGHT lines, suggest measures that the people of China could implement to reduce the continued damage caused to the ozone layer. (4x2) (8)**[15]**

ACTIVITY 2.1

MARKS 15 **TIME 15 MINUTES**

1.1. Refer to the diagram below showing the heating of the atmosphere and answer the set questions.



SOURCE:

1.1.1. What is *insolation*? (1x1) (1)

1.1.2. Name the THREE processes responsible for the loss of the sun's heat in the atmosphere. (3x1) (3)

1.1.3 Determine the percentage of the sun's energy eventually reaching the earth at **A**. (1x2) (2)

1.1.4. Name the process responsible for the release of heat energy by the earth to the atmosphere. (1x1) (1)

1.1.5. In a paragraph of approximately EIGHT lines, discuss the various ways in which the atmosphere is heated by the earth. (4x2) (8)

[15]