Class → 3

Origin | Structure | NCPA

4.6 Billion years

Atmosphere

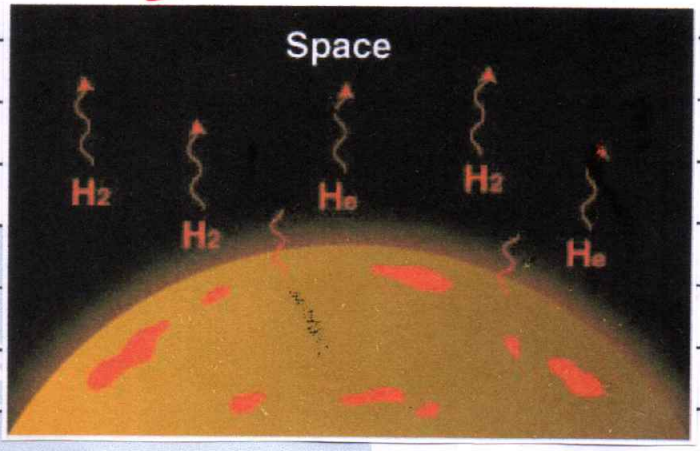
AQI

Temperature of Earth : ↑↑ means → very high at the time of origin.

Primordial Atmosphere

primary

composition of Hydrogen & Helium



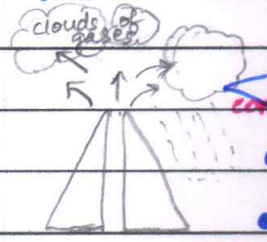
First Phase of Atmosphere : — At the time of origin due to very high temperature, the primordial atmosphere was lost. It is assumed that composition was mainly Hydrogen and Helium.

Origin

* **Volcanic action and gas release**

→ because of volcanic eruptions, there was a process of degasing.

degasing → means → release of gases.



also contains

contains

- NO_2
- SO_2
- CO_2
- Water Vapour
- Methane (CH_4)
- Dust Particles

* Green Plant :—

Photosynthesis
$CO_2 + H_2O \xrightarrow{\text{Photosynthesis}} C_6H_{12}O_6 + O_2$

Photolysis
$H_2 \xrightarrow{\text{Photolysis}} H_2 + O_2$

Structure of Atmosphere

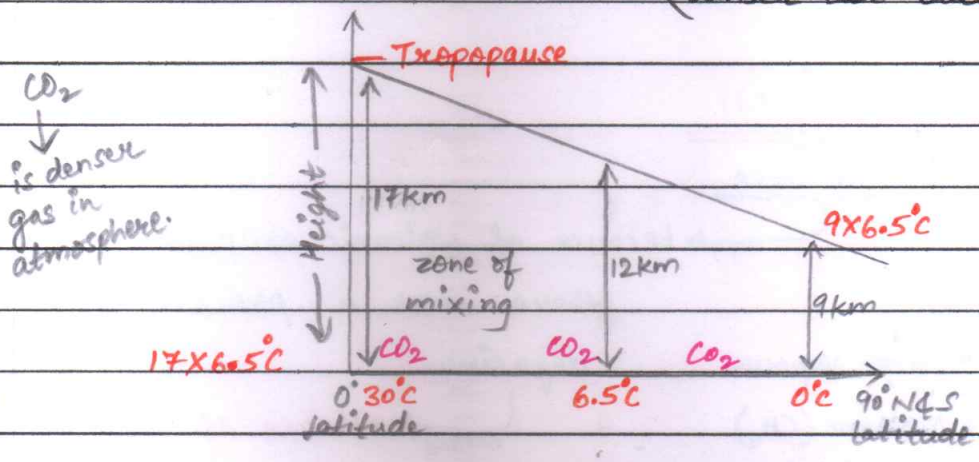
1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere
5. Ionosphere

(1.) Troposphere :—

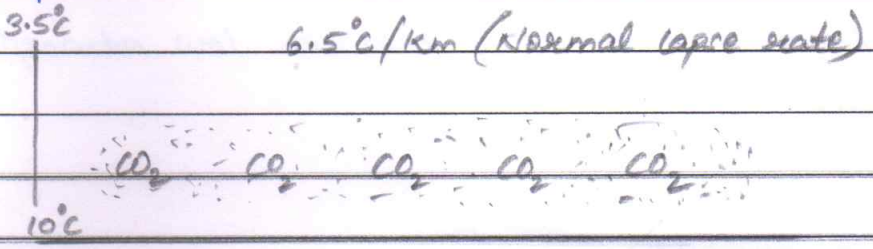
→ (i) Average Extent : → around 12 kms.

→ at equator → extent upto 17 kms.
(∵ of higher temperature & therefore more expansion & also ∵ of lesser gravity.)

→ at poles → extent upto 9 kms.
(∵ temperature is low & here is denser air subsides.)



→(ii) Zone of Mixing :— It is called as zone of mixing because all weather phenomenon are confined to Troposphere.



→(iii) Troposphere follows normal lapse rate.

→(iv) The tropopause at equator has lesser temperature than tropopause at poles.

17 × 6.5°C (equator)

(9 × 6.5°C) (poles)

• (2.) Stratosphere :—

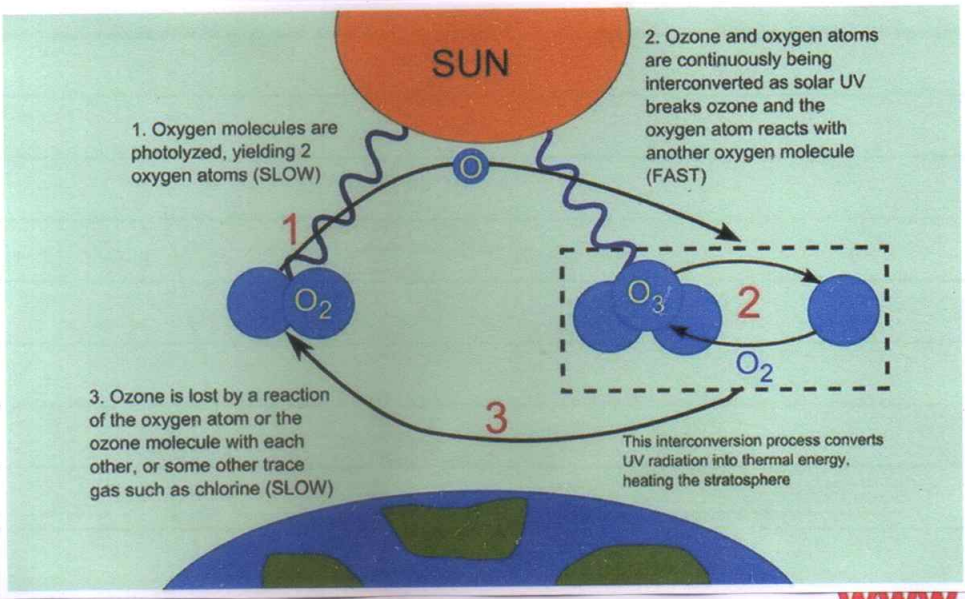
→(i) Extent upto :— 50 km.

→(ii) Ozonosphere :— upto 35 km.

$O_2 + O \rightarrow O_3$

Chapman's cycle / ozono-cycle

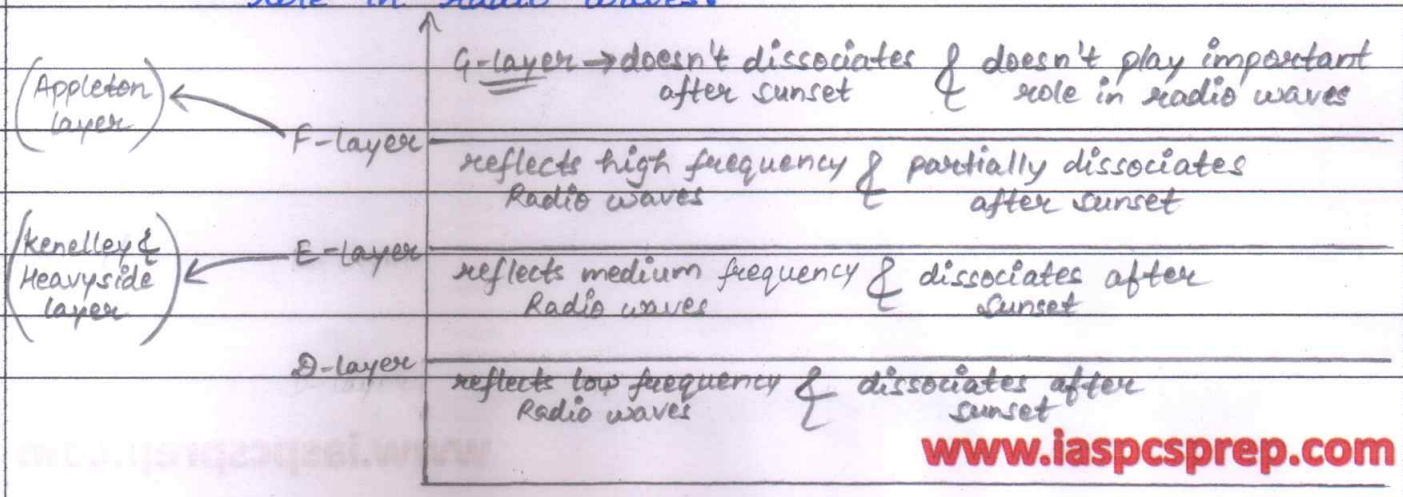
→ The thickness of ozone is greater at tropical latitudes than at polar latitudes.

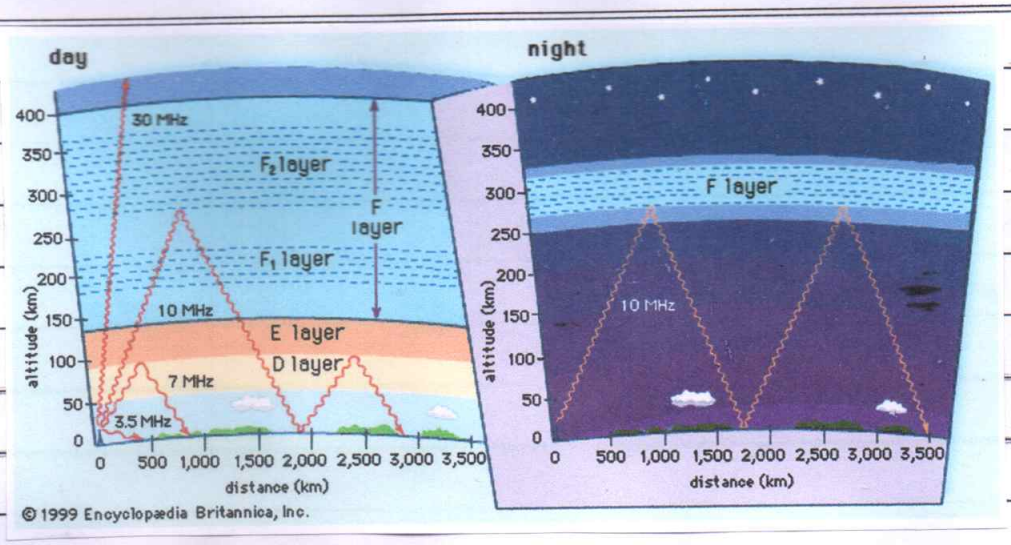


- (3.) **Mesosphere :——**
  - → (i) **Extent upto :——** 80 km.
  - → (ii) It is a transitory between low atmosphere and upper atmosphere.

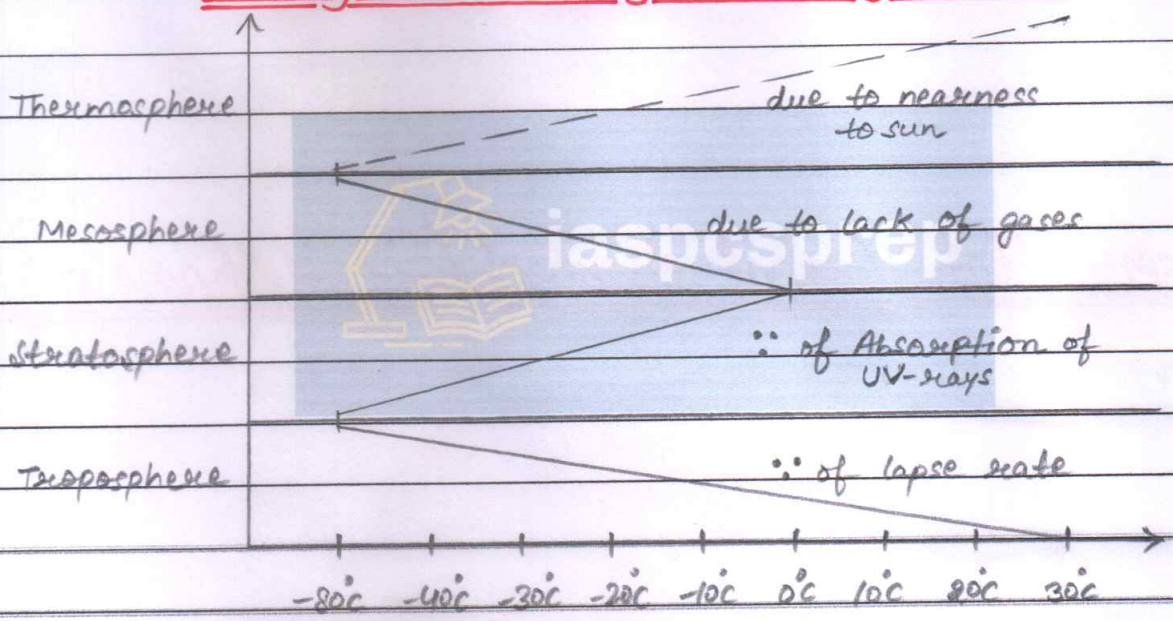
- (4.) **Thermosphere :——** It extends beyond 80 kms upto an average elevation of 400 kms.

- (5.) **Ionosphere :——** Ionosphere is divided in different layers :—
  - → (i) First layer (i.e. low layer) is called as D-layer. D-layer reflects low frequency radio waves and dissociates after sunset.
  - → (ii) Second layer is called as E-layer (also called as Kenelley and Heavyside layer). E-layer reflects medium frequency radio waves and also dissociates after sunset.
  - → (iii) Next layer is F-layer (also called as Appleton layer). F-layer reflects high frequency radio waves and partially dissociates after sunset.
  - → (iv) Above this, there is G-layer also. G-layer doesn't dissociates after sunset and doesn't play important role in radio waves.





Temperature of Atmosphere



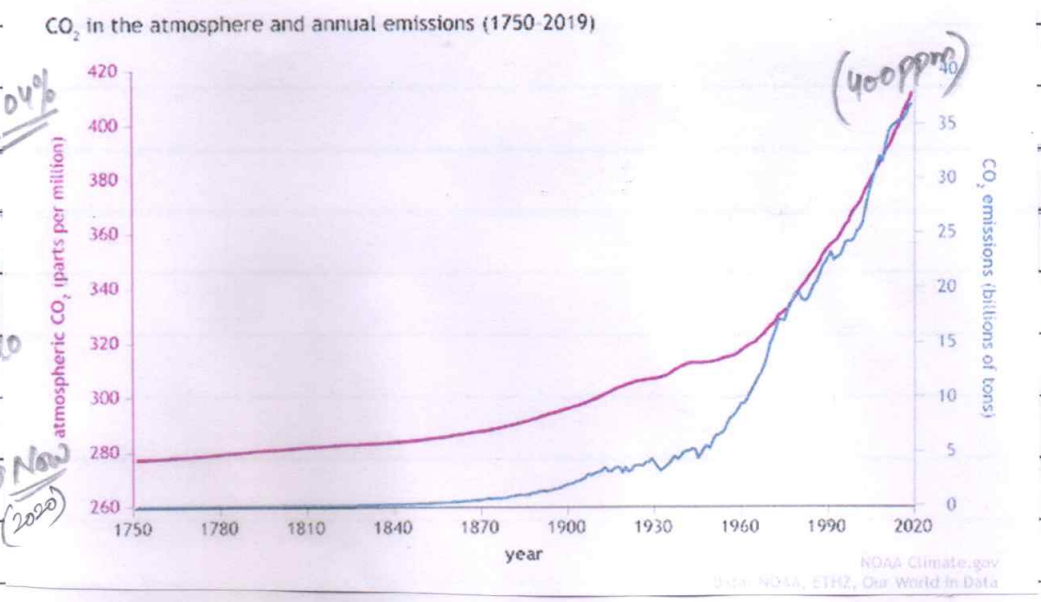
Present State (CO_2)

The amount of Carbon-dioxide in the atmosphere has increased along with human emissions since the start of the Industrial Revolution in 1750. CO_2 emissions rose slowly to about 5 billion tons a year in the mid-20th century before skyrocketing to more than 35 billion tons per year by the end of the

century.

Now, concentration of carbon-dioxide is → 0.04%

Till 2020, " " " " was → 0.038%

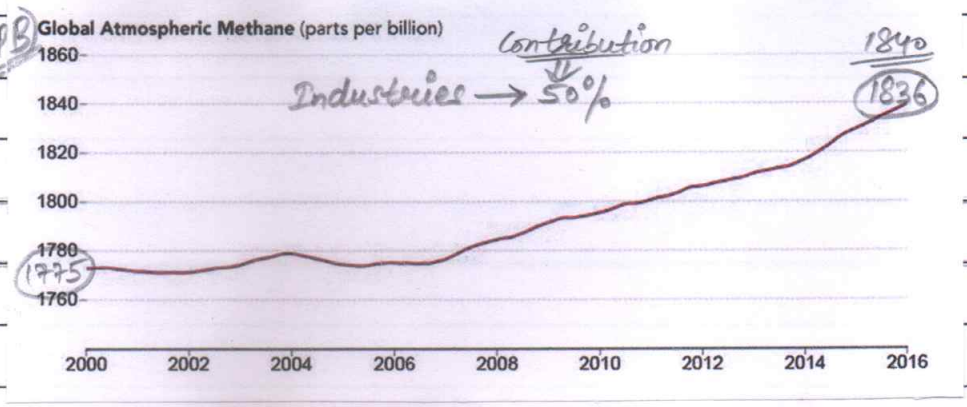


Now → 0.04% (2020)

0.038% ↓ Till 2020

400ppm → Now (2020)

Present State (Global Atmospheric Methane (ppb))



- The concentration of Methane has increased significantly in 21st century from 1775 ppb (2000) to 1840 ppb presently.

- Contribution :— 50% of the pollution or carbon-dioxide has comes from Industries, 27% from Vehicles, 17% from crop residues and 7% by domestic cooking etc.

Air Quality Index (AQI)

It is an index includes 8 major pollutants. A cumulative index is calculated at represence air quality which a colour is assigned.

1) PM_{10} (Particulate Matter → 10)
2) $PM_{2.5}$ (Particulate Matter → 2.5)
3) NO_2 (Nitrous Oxide)
4) O_3 (Ozone)
5) CO (Carbon Monoxide)
6) SO_2 (Sulphur Dioxide)
7) NH_3 (Ammonia)
8) Pb (lead)

Table 3.11 Breakpoints for AQI Scale 0-500 (units: µg/m³ unless mentioned otherwise)

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m³)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6 –1.0
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600	1201-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+*	34+	1600+	1800+	3.5+

*One hourly monitoring (for mathematical calculation only)

Image credit: National Air Quality Index Report by Central Pollution Control Board

National Clean Air Program (NCAP)

At the beginning of 2019, the Indian Government inaugurated the NCAP (National Clean Air Program) to address the situation. It is their aim to reduce levels of air pollution by 20% – 30% by 2024 in over 122 of the worst affected cities.

Previous Year Questions

Q(1). The jet aircrafts fly very easily and smoothly in the lower atmosphere. What could be the appropriate explanation?

(i) There are no clouds or water vapour in the lower stratosphere.

(ii) There are no vertical winds in the lower stratosphere.

Which of the statements given above is/are correct in this context?

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation :— The stratosphere is free from water vapour and dust particles. Absence of clouds and any other factors which may contribute to turbulence in the air makes it a perfect layer for flying jet aircrafts.

Q(2). The formation of ozone hole in the Antarctic region has been a cause of concern. What could be the reason for the formation of this hole?

a) Presence of prominent tropospheric turbulence; and inflow of Chloro-fluoro carbons.

b) Presence of prominent polar front and stratospheric clouds; and inflow of chlorofluorocarbons.

c) Absence of polar front and stratospheric clouds; and inflow of methane and chlorofluorocarbons.

d) Increased temperature at polar region due to global warming.

Explanation :— The severe depletion of stratospheric ozone in

late winter and early spring in the Antarctic is known as the "ozone hole". The formation of the Antarctic ozone hole is due to abundant reactive halogen gases, temperatures low enough to form Polar Stratospheric Clouds (PSCs), isolation of air from other stratospheric regions and sunlight. Presence of prominant polar front and stratospheric clouds; and inflow of chlorofluorocarbons (CFC) accelerates the ozone layer formation in Antarctica.

Class Quiz

Q①. What does the Air Quality Index (AQI) measure?

a) Humidity levels in the atmosphere
b) Concentration of greenhouse gases
c) Pollution levels in the air
d) Atmospheric pressure variations

Q②. Match the layers of Earth's atmosphere (List-I) with their altitudinal ranges (List-II):—

List-I	List-II
A. Troposphere	1. 80 – 550 km
B. Stratosphere	2. 0 – 12 km
C. Mesosphere	3. 50 – 80 km
D. Thermosphere	4. 12 – 50 km

Codes:—

	A	B	C	D
a)	2	4	3	1
b)	2	4	1	3
c)	4	2	1	3
d)	4	2	3	1

Q(3.) Match the components of the primordial atmosphere (List-I) with their approximate proportions (List-II):—

List-I	List-II
A. Hydrogen	1. 77%
B. Helium	2. 0.9%
C. Methane	3. 1%
D. Ammonia	4. 0.1%

Codes:—

	A	B	C	D
a)	1	2	3	4
b)	1	2	4	3
c)	3	2	4	1
d)	2	3	4	1

Q(4.) Match the column:—

Column-A	Column-B
A. Atmosphere	4. The gaseous envelope surrounding the Earth, composed of various gases and particles.
B. Air Quality Index (AQI)	3. A numerical scale used to communicate air quality levels to the public.
C. Particulate Matter (PM)	1. Measures the concentration of solid and liquid particles suspended in the air.
D. National Clean Air Program (NCAP)	2. A program aimed at reducing air pollution and improving air quality across a country.

Codes:—

	A	B	C	D
a)	4	3	1	2

b) 4 3 2 1
c) 3 4 1 2
d) 1 2 3 4

Q(5) What role did the escape of lighter gases like hydrogen and helium play in shaping Earth's early atmosphere?
a) They contributed to the formation of the ozone layer
b) They influenced the development of early life forms
c) They led to the loss of water vapour from the atmosphere
d) They facilitated the formation of volcanic eruptions

Q(6) Match the components of the National Clean Air Program (List-I) with their objectives (List-II) !—

List-I	List-II
A. Strengthening monitoring mechanisms	1. Reduce emissions from vehicles and industries
B. Promoting cleaner Production technologies	2. Enhance air quality data collection and analysis
C. Implementing stricter emission standards	3. Encourage industries to adopt cleaner processes

Codes !—

	A	B	C
a)	2	3	1
b)	2	1	3
c)	3	2	1
d)	1	2	3

Q(7.) Match the following pollutants with their impact on air quality :—

List - I	List - II
A. Carbon Monoxide (CO)	1. Irritates respiratory system, leads to lung diseases.
B. Sulfur dioxide (SO_2)	2. Reduces oxygen-carrying capacity of blood, affects cardiovascular system.
C. Nitrogen dioxide (NO_2)	3. Leads to smog formation and respiratory problems.
D. Particulate Matter (PM)	4. Causes acid rain & respiratory issues.

Codes :—

	A	B	C	D
a)	2	4	3	1
b)	2	4	1	3
c)	3	4	1	2
d)	3	4	2	1

Q(8.) Which atmospheric layer is characterized by the presence of the ozone layer ?

a) Troposphere
b) Mesosphere
c) Stratosphere
d) Thermosphere