Chapter 3: Atmosphere and Climate

Questions — Questions and activities

Q1 What is atmosphere? Explain its composition with the help of a pie diagram.

SOLUTION

The atmosphere is a blanket of air surrounding the Earth, held in place by gravity. It is a mixture of gases vital for the survival of all living beings. It shields us from harmful radiation, regulates the Earth's temperature by trapping solar energy, and drives weather and climate systems.

Composition: The two most abundant gases are nitrogen (78%) and oxygen (21%). Other gases include argon (0.93%), carbon dioxide (0.04%), and trace gases such as helium, neon, krypton, xenon, ozone, and hydrogen (together about 0.03%). The atmosphere also contains water vapour (0.1–0.4%) and tiny dust particles.

Pie diagram guidance: Draw a circle and divide it into sectors — the largest for Nitrogen (78%), the next for Oxygen (21%), a small sector for Argon (0.93%), a very small one for Carbon Dioxide (0.04%), and a sliver for Others (0.03%). Label each sector with its gas name and percentage. Use a different colour or shading for each sector and add a title: 'Composition of the Atmosphere'.

Answer: The atmosphere is the blanket of air surrounding the Earth. It is composed mainly of nitrogen (78%) and oxygen (21%), with argon (0.93%), carbon dioxide (0.04%), and trace gases making up the rest, along with water vapour and dust. Draw a pie chart with these five labelled sectors.

Q2 Draw a labelled diagram of the structure of atmosphere.

SOLUTION

Guidance: Draw a vertical rectangle or a curved cross-section of the Earth's surface at the base. Mark five horizontal layers from bottom to top, showing increasing altitude:

1. Troposphere (0–12 km) — label: 'Most weather phenomena; air we breathe; temperature decreases with altitude; separated from stratosphere by the tropopause.'

2. Stratosphere (12–50 km) — label: 'Contains ozone layer; ideal for aeroplane flight; free of clouds; boundary with mesosphere = stratopause.'

3. Mesosphere (50–80 km) — label: 'Temperature decreases with altitude; meteorites burn up here; boundary = mesopause.'

4. Thermosphere (80–700 km) — label: 'Temperature rises rapidly; reflects radio waves; auroras occur here; ionosphere is a part of it.'

5. Exosphere (above 700 km) — label: 'Uppermost layer; very thin air; light gases like helium and hydrogen escape into space.'

Show a temperature-altitude curve that zigzags (decreases in troposphere, increases in

stratosphere, decreases in mesosphere, increases in thermosphere). Add small icons: a cloud in the troposphere, an aeroplane in the stratosphere, a meteor in the mesosphere, a satellite/aurora in the thermosphere.

Answer: Draw five labelled horizontal layers from Earth's surface upward: Troposphere (0–12 km), Stratosphere (12–50 km, with ozone layer), Mesosphere (50–80 km), Thermosphere (80–700 km), and Exosphere (above 700 km). Include transition zones (tropopause, stratopause, mesopause) and a temperature-altitude curve.

Q3 Which are the four main seasons of India?

SOLUTION

The Indian Meteorological Department (IMD) has recognised four distinct seasons in India:

1. Winter (December to early April): The coldest months are December and January. Average temperature in north-west India is 10–15°C, rising to 20–25°C in south-east India.

2. Summer or Pre-monsoon (April to June, or up to July in north-western India): Average temperature across most of inland India ranges from 32–40°C.

3. Monsoon or Rainy — Advancing Monsoon (June to September): Dominated by the humid south-west monsoon, which brings most of India's annual rainfall.

4. Post-monsoon — Retreating Monsoon (October to December): Monsoon retreats from north India in October; south India receives more rainfall during this period.

Answer: The four main seasons of India are: (1) Winter (December–early April), (2) Summer/Pre-monsoon (April–June/July), (3) Monsoon/Advancing Monsoon (June–September), and (4) Post-monsoon/Retreating Monsoon (October–December).

Q4 Why do you not feel the pressure of the atmosphere?

SOLUTION

The atmosphere exerts a significant force on our bodies from all sides — from above, below, and the sides. However, the pressure inside our bodies is equal to the atmospheric pressure and cancels the pressure from outside.

Because air presses on us from all directions equally, and our bodies exert a counter-pressure in response, the forces balance out. As a result, we do not feel the weight or pressure of the atmosphere on us.

Answer: We do not feel atmospheric pressure because air presses on us equally from all sides, and the pressure inside our bodies matches the atmospheric pressure, exerting a counter-pressure that cancels it out. The forces are balanced, so we feel no net pressure.

Q5 In which layer of the atmosphere do aeroplanes fly and why?

SOLUTION

Aeroplanes fly in the stratosphere, the second layer of the atmosphere, which extends from the tropopause up to about 50 kilometres.

The stratosphere is ideal for flying aeroplanes for two main reasons: (1) It is completely free of clouds and other weather disturbances such as rainfall, hail, and fog, which are all confined to the troposphere below it. This makes the flight smooth and safe. (2) The stratosphere has stable air conditions, with temperature increasing with altitude, which further reduces turbulence.

Answer: Aeroplanes fly in the stratosphere (12–50 km). It is ideal for flight because it is completely free of clouds and weather disturbances, which are confined to the troposphere below, making air travel smooth and safe.

Q6 Distinguish between the following:
a. The troposphere and stratosphere
b. The south-west monsoon and north-east monsoon

SOLUTION

a. Troposphere vs. Stratosphere:

The troposphere is the lowest layer of the atmosphere, extending up to about 12 kilometres. Temperature decreases with increasing altitude in this layer. It contains the air we breathe, most water vapour and clouds, and is where almost all weather phenomena — rainfall, fog, hail — occur. It is separated from the stratosphere by the tropopause.

The stratosphere lies above the troposphere and extends up to 50 kilometres. Unlike the troposphere, its temperature increases with altitude. It is free of clouds and weather disturbances, making it ideal for aeroplane flight. A notable feature is the ozone layer within it, which filters the Sun's harmful ultraviolet radiation. Its upper boundary is the stratopause.

b. South-West Monsoon vs. North-East Monsoon:

The south-west monsoon (summer monsoon) occurs from June to September. Winds blow from the Indian Ocean, Arabian Sea, and Bay of Bengal towards the land. It is caused by the heating of the Indian landmass in summer, which creates a low-pressure area over the subcontinent, drawing moist oceanic winds inland. It accounts for most of India's annual rainfall.

The north-east monsoon (winter monsoon) occurs from October to February. During this season, the Indian landmass cools faster than the surrounding oceans, creating high pressure over land and low pressure over the seas. Cold and dry winds blow from land to sea. These winds generally do not bring rainfall to most parts of India, but when they pass over the Bay of Bengal, they pick up moisture and cause rainfall in Tamil Nadu, Andhra Pradesh, and parts of Karnataka.

Answer: a. The troposphere (0–12 km) has decreasing temperature with altitude and contains all weather phenomena; the stratosphere (12–50 km) has increasing temperature, no weather disturbances, and contains the ozone layer. b. The south-west monsoon (June–September) blows from sea to land bringing heavy rainfall; the north-east monsoon (October–February) blows from land to sea, bringing rain mainly to south-east India (Tamil Nadu and Andhra Pradesh) via the Bay of Bengal.

Q7 Do it yourself: Table 3.3 shows the average monthly temperatures and rainfall amounts for 10 representative stations. Study these figures on your own and convert them into 'temperature and rainfall' graphs. The visual representations will help you grasp their similarities and differences at a glance. One such graph (Fig. 3.14) is already prepared for you. See if you can arrive at some broad generalisations about our diverse climatic conditions.

7.1. Now look at Table 3.3 again. Re-arrange the 10 stations according to their distance from the equator.

7.2 Find out:

a. Two stations with the most extreme climate.

b. Two stations influenced by retreating monsoons.

c. The two hottest stations in the months of (i) February (ii) June

7.3. Now find out:

a. Why does Shillong experience more rainfall than Kolkata?

b. Why does Delhi receive more rainfall than Jodhpur?

7.4. Now think why

a. Thiruvananthapuram has an equable climate?

b. Chennai has more rainfall only after the fury of the monsoon is over in most parts of the country?

c. Leh has moderate precipitation almost throughout the year?

7.5. Despite these differences across regions, can you observe any substantial evidence to conclude that the monsoons provide a very strong framework, lending overall climatic unity to the whole country?

SOLUTION

Graph guidance: For each of the 10 stations in Table 3.3, draw a double-axis graph (like Fig. 3.14 for Delhi). Plot months (Jan–Dec) on the X-axis. Use the left Y-axis for temperature (°C) shown as a line graph, and the right Y-axis for rainfall (cm) shown as bars. Label each graph with the station name and latitude. Observe patterns: high rainfall during June–September at most stations (south-west monsoon signal), and the temperature peak in May–June in interior stations.

7.1. Stations re-arranged from closest to farthest from the equator (south to north by latitude):

1. Thiruvananthapuram (8°29'N)
2. Bengaluru (12°58'N)
3. Chennai (13°4'N)
4. Mumbai (19°N)

5. Nagpur (21°9'N)
6. Kolkata (22°34'N)
7. Shillong (24°34'N)
8. Jodhpur (26°18'N)
9. Delhi (29°N)
10. Leh (34°N)

7.2a. Two stations with the most extreme climate: Leh (very cold winters, e.g., −8.5°C in January, and very low annual rainfall of 8.5 cm — cold arid extreme) and Jodhpur (very high summer temperatures reaching ~33.9°C in June and very low annual rainfall of 36.6 cm — hot arid extreme). They represent the most extreme contrast in temperature and aridity.

7.2b. Two stations influenced by retreating monsoons (north-east monsoon): Chennai and Thiruvananthapuram. These stations on India's south-eastern/south-western coasts receive significant rainfall in October–November when the north-east monsoon picks up moisture from the Bay of Bengal after the south-west monsoon retreats.

7.2c. The two hottest stations in:
(i) February — Chennai (25.7°C) and Thiruvananthapuram (27.3°C) are the hottest in February, being closest to the equator with high insolation throughout the year.
(ii) June — Jodhpur (33.9°C) and Delhi (33.3°C) are the hottest in June, as these interior north Indian locations experience intense heating in the pre-monsoon period before rains arrive.

7.3a. Shillong (at 1,461 m altitude) receives more rainfall than Kolkata because it is located in the Meghalaya hills, where the south-west monsoon winds are forced to rise rapidly along the hillsides. This orographic lifting causes the air to cool and condense, producing very heavy rainfall. Kolkata, situated on the flat Gangetic plain, does not benefit from this relief effect and thus receives less rainfall.

7.3b. Delhi receives more rainfall than Jodhpur because the Bay of Bengal branch of the south-west monsoon moves north-westward over the Gangetic plain, bringing moisture to Delhi. Jodhpur, located in the Thar Desert region of Rajasthan, is in the rain-shadow interior where monsoon winds lose their moisture before reaching it. Additionally, the Aravallis run parallel to the Arabian Sea branch of the monsoon, failing to cause orographic lifting over Jodhpur.

7.4a. Thiruvananthapuram has an equable climate because it is located near the sea (coastal location) and close to the equator. The proximity of the sea moderates temperatures — the sea heats and cools more slowly than land, so summers are not too hot and winters are not too cold. Additionally, its low latitude ensures consistent insolation throughout the year, keeping temperatures relatively stable.

7.4b. Chennai receives more rainfall after the fury of the south-west monsoon is over in most parts of the country because it lies on the eastern (Coromandel) coast of India. The south-west monsoon approaches India from the west and south-west and largely bypasses Chennai as it passes to the west of the Eastern Ghats. However, when the north-east (retreating) monsoon picks up moisture from the Bay of Bengal in October–December, it brings heavy rain to

Chennai and the south-eastern coast.

7.4c. Leh (at 3,506 m altitude) has moderate but fairly consistent precipitation almost throughout the year because it lies in a high-altitude cold desert beyond the Himalayas. The Great Himalayas block most of the south-west monsoon's moisture, so Leh does not receive heavy monsoon rains. Instead, it receives small amounts of precipitation from western disturbances in winter and spring, and some light rain/snow in other months, spread more or less evenly across the year.

7.5. Yes, the data from Table 3.3 provides clear evidence that the monsoon lends climatic unity to India. Almost all 10 stations — from Thiruvananthapuram in the south to Delhi and Shillong in the north — show a marked rise in rainfall during June to September, coinciding with the south-west monsoon season. Even stations like Leh, which receive less moisture, follow the broader seasonal pattern. Stations in southern and eastern India show a secondary peak in October–November due to the north-east monsoon. This seasonal rhythm of rain and dry periods, shared across diverse geographic settings, creates a common climatic thread — the monsoon framework — that unifies India's varied climate into a coherent pattern.

Answer: Guidance: For each station, draw a temperature line graph (left axis) and rainfall bar graph (right axis) against months. 7.1: South to north by latitude: Thiruvananthapuram, Bengaluru, Chennai, Mumbai, Nagpur, Kolkata, Shillong, Jodhpur, Delhi, Leh. 7.2: Most extreme = Leh (cold arid) and Jodhpur (hot arid); retreating monsoon = Chennai and Thiruvananthapuram; hottest in February = Thiruvananthapuram and Chennai; hottest in June = Jodhpur and Delhi. 7.3: Shillong has orographic rainfall from hills; Jodhpur is in the rain-shadow interior. 7.4: Thiruvananthapuram is coastal and near the equator; Chennai is bypassed by the south-west monsoon but receives the north-east monsoon; Leh is a high-altitude cold desert shielded by the Himalayas. 7.5: Yes — nearly all stations show peak rainfall in June–September, confirming the monsoon as India's unifying climatic framework.

Q8 Collect pictures of houses and clothing of people from different regions of India. Examine whether they reflect any relationship with the climatic conditions or the relief of those regions.

SOLUTION

This is a project activity. Collect pictures from books, newspapers, magazines, or the internet showing houses and traditional clothing from different Indian regions.

As you examine them, look for these relationships with climate and relief:

Houses: In high-rainfall regions like Kerala or Meghalaya, houses typically have steep sloping roofs to drain rainwater quickly. In hot and arid regions like Rajasthan, houses have thick mud walls and small windows to keep the interior cool. In cold mountainous regions like Ladakh or Himachal Pradesh, houses are built of stone with flat roofs (used to store fodder) to withstand snow. In flood-prone river plains, some houses are built on raised platforms.

Clothing: In cold Himalayan regions, people wear woollen garments, shawls, and furlined coats. In hot and dry Rajasthan, light cotton with head covers (turbans/odhni) are traditional,

protecting against heat and dust. In humid coastal regions, light and airy clothing like lungis and cotton sarees are preferred. In rainy regions, people use traditional rain-gear like the coir or bamboo hat (japi in Assam) for protection.

Conclusion: The housing styles and clothing across India clearly reflect adaptations to the local climate (temperature, rainfall, wind) and the physical relief (mountains, plains, coast, desert). This shows a deep connection between geography and culture.

Answer: Model answer: Houses in rainy regions have steep sloping roofs (e.g., Kerala, Meghalaya); arid regions have thick mud walls with small windows (Rajasthan); cold mountains have stone-walled houses (Ladakh). Clothing is woollen in cold Himalayan areas, light cotton in hot and humid regions, and head-covering turbans in desert areas. These reflect direct adaptations to local climate and relief.